PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Number.	:	09/237,605
Applicants	:	Richard J. Lazzara et al.
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Title		Infection-Blocking Dental Implant
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Examiner	:	Paul Prebilic
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CERTIFICATE OF MAILING
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AMENDED APPEAL BRIEF UNDER 37 C.F.R. 41.37

Sir:

A Notice of Appeal was received at the USPTO on December 27, 2004 in the subject application. An Appeal Brief was filed April 27, 2005. This amended Appeal Brief is submitted pursuant to a notification of Non-Compliant Appeal Brief under 37 C.F.R. 41.37(d) mailed July 11, 2005.

1. REAL PARTY IN INTEREST – RULE 41.37(c)(1)(i)

The inventors have assigned the subject application to Implant Innovations, Inc., the real party in interest.

2. RELATED APPEALS AND INTERFERENCES – RULE 41.37(c)(1)(ii)

There are no other appeals or interferences that will directly affect or be directly affected by or have a bearing on the Board of Patent Appeals and Interferences in the present appeal.

3. STATUS OF CLAIMS – RULE 41.37(c)(1)(iii)

The claims have the following status:

Claim No.	Status
1-10	Cancelled
11-16	Cancelled in Amendment filed with this Appeal Brief
17-50	Cancelled
51	Rejected and appealed
52-56	Cancelled
57-59	Cancelled in Amendment filed with this Appeal Brief
60-75	Rejected and appealed

No claims have been allowed.

Claims 11-16 and 57-59 (now cancelled) were rejected under 35 U.S.C. § 103(a) as being obvious in view of the combination of JP 3-146679 to Haruyuki et al, which has an English translation ("Haruyuki"), and U.S. Patent No. 4,826,434 to Krueger ("Krueger").

Claims 51 and 60-75 were rejected under 35 U.S.C. § 103(a) as being obvious in view of the combination of Haruyuki and U.S. Patent No. 5,571,017 to Niznick ("Niznick").

Copies of the Haruyuki[1], Kreuger, and Niznick are attached as Appendices B, C and D, respectively. A copy of the Final Office Action mailed July 23, 2004 that finally rejected the claims is attached as Exhibit E. A copy of the Advisory Action mailed December 9, 2004 is attached as Exhibit F.

Claims 51 and 60-75 are being appealed.

[1] The English translation of Haruyuki was provided by the Patent Office. The photographs at the end of the Appendix B are from the Japanese Patent Office, which were submitted in Exhibit 1 in the Amendment dated June 26, 2003.

4. STATUS OF AMENDMENTS – RULE 41.37(c)(1)(iv)

Subsequent to the Final Office Action of July 23, 2004 (Exhibit E) and pursuant to a telephone interview on November 18, 2004, an Amendment and Response to the Final Office Action was filed November 23, 2004. In an Advisory Action mailed December 9, 2004 (Exhibit F), the Examiner advised that the proposed amendments would be entered and that the rejections under 35 U.S.C. § 112, first and second paragraphs had been withdrawn. Consequently, claims 11-16, 51, and 57-75 remained rejected based on 35 U.S.C. § 103(a).

The Applicants, however, have chosen to simplify the issues on appeal. The owner of the pending application is in the dental implant industry. Accordingly, claims 11-16 and 57-59, which are directed to implants generally, have been cancelled so as to focus this appeal on claims 51 and 60-75, which are specifically directed to dental implants having head portions for receiving dental restoration components. An Amendment Under Rule 41.33 that cancels claims 11-16 and 57-59 is being filed with this Appeal Brief. A copy of the Amendment Under Rule 41.33 is also attached under Exhibit A.

5. SUMMARY OF CLAIMED SUBJECT MATTER – RULE 41.37(c)(1)(v)

For the Board's convenience, the following summary will refer to a specification prepared for this Appeal Brief and attached as Exhibit G. The specification combines the as-filed specification with the addition of extended passages (shown in italics) contained in amendments mailed March 11, 1999 and February 9, 2001 and the up-dated cross-reference in the Amendment dated August 6, 2001.

General Subject Matter of the Independent Claims 51, 63, and 68

Each of the independent Claims 51, 63, and 68 is directed to a dental implant 10 (Fig. 1) that is to be surgically implanted in living bone (page 4, lines 1-2) and that osseointegrates with the living bone (page 4, lines 1-2). In each claim, the dental implant has a head portion 12 (Fig. 1) that receives a dental restoration component (page 1, lines 12-13; page 4, lines 30-31). Each dental implant 10 has a lowermost end opposing the head portion 12, which includes a threaded

portion (Fig. 1) that engages the living bone (page 3, lines 1-7 and 16, 20 in Fig. 1). Other features of each of the independent claims are summarized below.

Independent Claim 51

The head portion 12 is smooth (page 4, lines 2-4). The roughened region 18 (Fig. 1) for facilitating osseointegration with bone is located on the threaded portion and extends to the lowermost end of the implant 10 (Fig. 1). The roughened region 18 is uniformly acid-etched (page 7, lines 19-23) after a native oxide layer has been removed by a first acid solution (page 6, lines 8-10) (page 7, lines 11-12). The first acid solution removes the native oxide layer with minimum consumption of titanium metal (page 6, lines 23-25). A substantially array of irregularities having peak-to-valley heights not greater than about 10 microns is produced (page 8, lines 22-23).

Independent Claim 63

The head portion 12 includes a non-rotational feature 17 (Figs. 1 & 2) for engaging a dental restoration component (page 4, lines 30-31) and a smooth machined surface (page 3, lines 32-40; page 4, line 4). The threaded portion has continuous thread turns (Fig. 1) and includes a self-tapping region adjacent to the lowermost end (Fig. 1). The threaded portion has an acid-etched surface (page 7, lines 19-23) extending to the lowermost end of the implant 10 (Fig. 1) and within the self-tapping region. The acid-etched surface is produced on the threaded portion after a native oxide layer has been removed (page 6, lines 1-2). The acid-etched surface having a substantially uniform of irregularities having peak-to-valley heights not greater than about 10 microns (page 8, lines 22-23). The irregularities include cone-shaped elements (page 8, lines 23-25).

Independent Claim 68

The head portion 12 for receiving a dental restoration component (page 4, lines 30-31) includes a non-rotational feature 17 (Figs. 1 & 2). The threaded portion has continuous thread turns (Fig. 1) located between the head portion and the lowermost end (Fig. 1). The threaded portion includes a cylindrical section (Fig. 1 & 2) and a tapered section immediately adjacent to

the lowermost end (Fig. 1). The cylindrical section is longer than the tapered section (Fig. 1). The tapered section includes a self-tapping region that extends to the lowermost end (Fig. 1). The threaded portion has an acid-etched surface (page 7, lines 19-23) for facilitating osseointegration with bone (page 4, lines 1-2). The acid-etched surface extends from the lowermost end into the cylindrical section of the threaded portion (Fig. 1) and is produced on the threaded portion after a native oxide layer has been removed (page 7, lines 11-12). The acid-etched surface has a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns (page 8, lines 22-23). The irregularities include cone-shaped elements (page 8, lines 23-25).

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL – RULE 41.37(c)(1)(vi)

Only one rejection remains for review. Claims 51 and 60-75 were rejected under 35 U.S.C. § 103(a) as being obvious in view of the combination of Haruyuki and Niznick. Haruyuki was cited for disclosing an acid-etched titanium implant, including dental implants, with recesses having average depths of 0.5 to 5 microns. Niznick was cited for teaching that it was known in the art to have different regions of roughness below the top surface, a tapered section, and a self-tapping feature.

7. ARGUMENT – RULE 41.37(c)(1)(vii)

Sub-heading I will discuss the pertinent law on obviousness.

Sub-heading II will discuss Haruyuki, the primary reference upon which the rejection is based.

The claims related to the one ground of rejection for this appeal will be discussed in four groupings as indicated by sub-heading III (claims 51, 60, and 62), sub-heading IV (claims 63-66), sub-heading V (claims 68-71 & 73-75) and sub-heading VI (claims 61, 67, & 72).

Sub-heading VII will discuss secondary evidence of non-obviousness.

I. The Law of Obviousness

Obviousness requires that all the limitations of a claim must be taught or suggested by the combined prior art references. M.P.E.P. § 2143.03 (citing *In re Royka*, 490 F.2d 981, 985, 180 U.S.P.Q. 580, 583 (C.C.P.A. 1974)). A *prima facie* case of obviousness requires three basic criteria:

> First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure.

M.P.E.P. § 2143 (citing *In re Vaeck*, 947 F.2d 488, 493, 20 U.S.P.Q.2d 1438, 1442 (Fed. Cir. 1991).

Although a prior art reference may be modified to meet the claimed limitation, the resultant modified reference is not obvious unless the prior art also suggests or motivates the desirability of the modification. *In re Mills*, 916 F.2d 680, 682, 16 U.S.P.Q.2d 1430, 1432 (Fed. Cir. 1990) (citing *In re Gordon*, 733 F.2d 900, 902, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984)). Obviousness cannot "be established using hindsight or in view of the teachings or suggestions of the invention." *Ex parte Maguire*, 2002 WL 1801466, *4 (Bd. Pat. App. & Inter. 2002) (quoting *Para-Ordnance Mfg. Inc. v. SGS Importers Int'l Inc.*, 73 F.3d 1085, 1087, 37 U.S.P.Q.2d 1237, 1239 (Fed. Cir. 1995), *cert. denied*, 519 U.S. 822 (1996)). Further, the proposed modification cannot render the prior art "unsatisfactory for its intended purpose" nor can it "change the principle of operation" of a reference. M.P.E.P. § 2143.01 (citing *In re Gordon*, 733 F.2d at 902, 221 U.S.P.Q. at 1127 and *In re Ratti*, 270 F.2d 810, 813, 123 U.S.P.Q. 349, 352 (C.C.P.A. 1959)). Furthermore, references cannot be combined where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983).

The law of obviousness requires that a reference be considered as a whole, including those portions that teach away from the Applicant's claimed invention. *See W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.3d 1540, 1550-51, 220 U.S.P.Q. 303, 311 (Fed. Cir. 1983) ("[T]he totality of a reference's teaching must be considered."); *see also* M.P.E.P. § 2141.02 (stating that prior art must be considered in its entirety including disclosures that teach away from the claims).

Indicia of teaching away in a reference gives insight into the question of obviousness. *Monarch Knitting Mach. Corp. v. Sulzer Morat GMBH,* 139 F.3d 877, 885, 45 U.S.P.Q.2d 1977, 1984 (Fed. Cir. 1998). A prior art reference may be considered to teach away when "a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant." *Monarch Knitting*, 139 F.3d at 885, 45 U.S.P.Q.2d at 1984 (quoting *In re Gurley*, 27 F.3d 551, 553, 31 U.S.P.Q. 1130, 1131 (Fed. Cir. 1994)).

II. The Haruyuki Reference

The Examiner contends that "since a similar type of etching process is used ...", Haruyuki's surface would "inherently" be the same as the Applicants' surface. Final Office Action, page 5. If the Examiner is correct in citing Haruyuki for producing a similar surface from a similar process, then it should be evident that the surfaces are, in fact, similar. Based on the Applicants' significant testing set forth in a Declaration under 37 C.F.R. § 1.132 by Dr. Prabbu Gubbi, attached in Exhibit I and submitted on June 26, 2003, the Applicants respectfully suggest that (i) Haruyuki's roughened surface does not "inherently" correspond to the Applicants' surface and (ii) Haruyuki's surface cannot be duplicated.

Regarding Haruyuki, the English translation teaches a method of treating the surface of a titanium implant with a solution of hydrofluoric acid, which is then followed by post-treatment with a solution of hydrofluoric acid and hydrogen peroxide. The initial treatment with a solution of hydrofluoric acid is said to create pits which have sharp edges and sharp spines. Then, the post-treatment with the solution of hydrofluoric acid and hydrogen peroxide is performed to **smoothen** the sharp edges and sharp spines, which can cause tissue irritation. Haruyuki, p. 4, first column. Thus, Haruyuki does not teach a second treatment that **roughens** the surface from which the native oxide had been removed. Haruyuki teaches to smoothen the sharp edges and sharp spines produced by the first treatment, rather than to further roughen the surface.

From Haruyuki's photographs, attached in Exhibit B, it is clear that the surfaces have a topography different from the Applicants' surface, perhaps due to the fact that the Applicants further roughen the surface after the native oxide is removed, while Haruyuki smoothens the surface created by the first step. To further compare Haruyuki's results with the Applicants'

results, the Applicants have conducted several experiments. The results were reported in the Declaration under 37 C.F.R. § 1.132 by Dr. Prabbu Gubbi, found in Exhibit I. The Applicants' surface (*i.e.*, the Osseotite® surface) is shown in Exhibit A of the Gubbi Declaration. The results of repeating Haruyuki's experiments are reported in Exhibit B of the Gubbi Declaration.[2] It is clear from the photomicrographs presented in Exhibit A of the Gubbi Declaration that the Applicants' Osseotite® surface is not obtained when the methods of Haruyuki's examples, shown in Exhibit B, are repeated. Furthermore, Haruyuki's photographs in Exhibit B do **not** resemble the surface achieved when Haruyuki's tests were repeated by Dr. Gubbi (Exhibit I, Section B), which leaves the Applicants questioning Haruyuki's methodology.

While the Board is encouraged to review the results of Dr. Gubbi's extensive Declaration in detail, for the Board's convenience, a one-page comparison including selected photographs from Dr. Gubbi's Declaration is included in Exhibit H. The purpose of this one-page comparison in Exhibit H is to easily compare (i) the surface that Haruyuki illustrated in Haruyuki's Japanese patent application as the desired surface (Example 2 of Exhibit B), (ii) the surface that resulted from Dr. Gubbi's attempt to replicate Haruyuki's process, and (iii) the commercial Osseotite® surface according to the claimed invention.

In Exhibit H, the first row shows the surface after Haruyuki's first step (Haruyuki's FIG. 2) in which a titanium surface is treated with 4 % HF for 1 minute, creating a rough surface. Haruyuki's FIG. 4 shows a surface after two steps, including Haruyuki's "post-treatment" with 4 % HF and 8 % H_2O_2 for 15 seconds. Haruyuki's FIGS. 2 and 4 appear very similar, as might be expected, since Haruyuki teaches that the second treatment was only to "smoothen" the sharp edges and sharp spines created in his first treatment.

In the second row of Exhibit H, the attempt to duplicate Haruyuki's process are shown. These results are taken from Exhibit B of Dr. Gubbi's Declaration. Clearly, the process set forth in Haruyuki could not be repeated to produce the results that Haruyuki allegedly obtained.

In the third row of Exhibit H, a surface according to the Applicants' invention is disclosed after the first step (treatment with HF) and after the second step (mixture of HCl and

[2] Exhibits C and D to Dr. Gubbi's Declaration relate to tests showing results of acid-etching with various mineral acids, and tests showing results of grit-blasting plus various acid-etching steps, respectively.

H_2SO_4). The first step produces a relatively smooth surface. The second step produces a roughened surface.

Accordingly, in addition to the fact that Haruyuki discloses a process that could **not** be repeated by a skilled artisan (Dr. Gubbi), the surfaces disclosed by Haruyuki are different from the claim surfaced. The Examiner's position is that if "a similar type of etching process is used [by Haruyuki] to form irregularities on the surface of the same material as claimed," then "the surface irregularities of Haruyuki would inherently be the same as those set forth claims." Final Office Action, p. 5. The Applicants respectfully suggest that the extensive testing that they have done **completely disproves** the Examiner's position on this point.

III. The 103 Rejections of Claims 51, 60, and 62

Claims 51, 60, and 62 have been rejected under 35 U.S.C. § 103(a) based on the combination of Haruyuki and Niznick. Independent claim 51 requires:

- **a smooth head portion** for receiving a dental restoration component;
- a roughened region located on said threaded portion and **extending to** said lowermost end of said implant; and
- the roughened surface is **uniformly acid etched** and characterized by having a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns.

In other words, claim 51 requires, below the smooth head portion, a uniformly acid-etched surface extending from the threaded portion all the way to the lowermost end, and that this uniformly acid-etched surface has a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns.

Haruyuki was cited by the Examiner for allegedly having the acid-etched surfaces defined by claim 51. As mentioned above, the Applicants dispute the Examiner's position. Niznick was cited for teaching different regions of roughness and the location for the different regions of roughness. Yet, as discussed below, Niznick's teaching of where, and to what degree, to roughen the implant is **substantially** different from the invention of claims 51, 60, and 62, and it is **substantially** different from Haruyuki's teaching.

A. Niznick and Haruyuki Teach Away From Their Combination

Haruyuki is very specific about what type of surface he desires. After providing several different examples using modified process steps, Haruyuki concludes that the microscopic depressions should have an average depth of 0.5 to 5 microns. Haruyuki, p. 4, col. 1, lines 1 to 5. Haruyuki also explains his reasoning.

> The bases for specifying an average depth in the range of 0.5 to 5 microns are as follows: the anchoring effect between the bone and biorepair member is low at an average depth below 0.5 microns; **an average depth in excess of 5 microns,** although providing anchoring effect, **tends to result in the appearance of sharp spines and sharp edges at the ridge lies between depressions, which can cause to issue irritation (possibly a trigger for cancer).**"

Haruyuki, p. 4, col. 1, lines 22 to 32 (latter emphasis added). In other words, Haruyuki's primary concern is that if the depth of the microscopic depressions on the implant's surface exceeds 5 microns, then there is a detrimental effect, which can possibly lead to a grave situation for the patient – **cancer**. Haruyuki tested various types of processes and discards several of them because they produced the "sharp edges" and "sharp spines," which leads to the peak-to-valley height being greater than 5 microns and the associated detrimental effects. (*see e.g.* Haruyuki, pp. 7-8).

So, what does Niznick teach? Compared to Haruyuki, Niznick teaches that the implant's surface should be **exceedingly** rough. In fact, Niznick teaches that the main portion of the implant's surface should be **at least five times greater** than the surface specified by Haruyuki. When describing the first embodiment of FIG. 1, Niznick states:

> The darkened, external, threaded, middle region 14 is relatively rough, with the average peak-to-valley distance of the surface texture **being 25 microns or greater** which is at least 25% greater than the roughness of the uncoated self-tapping threads at distal end or uncoated proximal end surfaces 2 and 3.

Niznick, Col. 7, lines 11-14. (emphasis added) And, when describing the only other illustrated embodiment, which is shown in FIG. 2, Niznick repeats the same teaching:

> Implant 20 has a darkened, external, threaded, middle region 27 with a surface that is relatively rough, with the average peak-to-valley distance of the surface texture **being 25 microns or greater** which is at least 25 percent greater than the roughness of the uncoated self-tapping threads 21 at [the] distal end and relatively smooth uncoated proximal end 26.

Niznick, Col. 7, lines 11-14. (emphasis added).

Consequently, while Haruyuki teaches the skilled artisan to avoid surfaces where the peak-to-valley height of the surface texture is greater then 5 microns because of potential biological problems, such as cancer, Niznick teaches that same skilled artisan to employ a surface where the peak-to-valley height of the surface texture is 25 microns or greater. In fact, the exceedingly rough implant **is** Niznick's invention as can be seen by reviewing Niznick's claim 1.

But, the differences between the surface texture taught by Haruyuki and the surface texture taught by Niznick do not just relate to the dimensions of the surface texture -- they also relate to the surface texture itself. Niznick teaches that the surface texture with the peak-to-valley heights of 25 microns or greater should be created from an HA (hydroxylapatite) coating, TPS (titanium plasma spray) coating, or grit blasting, all of which introduce foreign matter to the underlying implant surface. Niznick, Col. 7, lines 17-18 and 47-48.

Haruyuki knew about these types of material-adding processes that can increase the surface roughness. But, Haruyuki, who touts his HF acid-etching process, teaches the skilled artisan of the problems associated with these type of material-adding process, such as introducing "biotissue contamination" to the patient, and/or operational complexity and high-cost. Haruyuki, p. 3, col. 1. As such, this is yet another direct contradiction between Haruyuki and Niznick teachings on surface texture.

It is axiomatic that the entire teachings of the references must be considered when determining obviousness. When doing so here, the skilled artisan would **never** combine the teachings of Niznick with those of Haruyuki to produce Applicants' invention of claim 51. Prior art references simply cannot be combined where the references teach away from their combination. *In re Grasselli*, 713 F.2d at 743, (Fed. Cir. 1983); MPEP §§ 2143, 2145.

B. Niznick Teaches Away From The Invention of Claim 51

Claim 51 requires a smooth head portion and a threaded portion with a roughened region **extending to the lowermost end,** wherein the roughened region has a substantially uniform array of irregularities having peak-to-valley heights no greater than about 10 microns. This configuration is not disclosed in Niznick, and Niznick actually teaches away from it with his three-part surface roughness.

Niznick teaches the implant's lowermost end at the self-tapping region 8 (FIG. 1) or 21 (FIG. 2) should be roughened up to a peak-to-valley height of 20 microns. Column 5, lines 16-20; Column 7, lines 11-15 & 41-45. Niznick considers this surface "relatively smooth" compared to the middle threaded region 14 (column 7, line 26), which has the peak-to-valley height of **at least 25 microns** brought about through a material-adding process, such as HA coating, TPS coating, or grit blasting. In fact, these extremely rough surfaces at the **three** distinct locations (*i.e.*, (i) the distal end where the self-tapping feature resides, (ii) the proximal end at the top of the implant, and (iii) the middle region with the peak-to-valley heights of **at least 25 microns**) are the subject matter of Niznick's claim 1. As such, what Niznick considered to be a "relatively smooth" is much rougher than the Applicants' acid-etched surface.

Claim 51 requires a "smooth head portion" and a threaded portion with a roughened region **being uniformly acid-etched and extending to the lowermost end.** The roughened region has a substantially uniform array of irregularities having peak-to-valley heights **no greater than about 10 microns.** To make this rejection, the Examiner has ignored the fundamental teaching of Niznick -- the extremely rough surface of **at least 25 microns** (which is not, of course, uniformly acid-etched) – that teaches away from claim 51. A prior art reference that teaches away from the claimed invention is a significant factor to be considered in determining obviousness.

Because the proposed combination of Haruyuki and Niznick is improper for several reasons, the Applicants respectfully request the reversal of the rejections of claims 51, 60, and 62, which are believed to be in a condition for allowance.

IV. The 103 Rejections of Claims 63-66

Claims 63-66 have been rejected under 35 U.S.C. § 103(a) based on the combination of Haruyuki and Niznick. Claim 63 requires:

- **a head portion having a smooth machined surface** and for receiving a dental restoration component;
- a threaded portion including a self-tapping region adjacent to said lowermost end;
- said threaded portion having an acid-etched surface;
- said acid-etched surface **extending to said lowermost end of said implant and within said self-tapping region**; and
- said acid etched surface having a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns.

As noted above with respect to claims 51, 60, and 62, the combination of Haruyuki and Niznick fails because (i) Haruyuki and Niznick are directly contradictory to each other in several respects relative to the type of surface texture they teach, and (ii) Niznick teaches away from several aspects of the claimed acid-etched surface. Accordingly, for the reasons set forth above, the rejections of claims 63-66 should be reversed.

Additionally, independent claim 63 includes limitations regarding the self-tapping feature of the dental implant and, specifically, that the acid-etched surface with the substantially uniform array of irregularities is located within the self-tapping feature. Niznick, on the other hand, does **not** teach an acid-etched surface that extends along the threaded portion of the dental implant, into the self-tapping region, and to the lowermost end of the implant. Again, the middle threaded portion of Niznick's implant that is roughened does **not** extend to the lowermost end of the implant or into the self-tapping region. As such, Niznick not only does not suggest such a configuration of claims 63-66, but actually teaches away from it. Simply put, Niznick fails to overcome the deficiencies of Haruyuki.

The Applicants respectfully request the reversal of the rejections of claims 63-66. Claims 63-66 are believed to be in a condition for allowance.

V. The 103 Rejections of Claims 68-71 and 73-75

Claims 68-71 and 73-75 have been rejected under 35 U.S.C. § 103(a) based on the combination of Haruyuki and Niznick. Claim 68 requires:

- **a head portion having a smooth machined surface** and for receiving a dental restoration component;
- a threaded portion including a self-tapping region adjacent to said lowermost end;
- said threaded portion including a cylindrical section and a tapered section immediately adjacent to said lowermost end, said cylindrical section being longer than said tapered section;
- said threaded portion having an acid-etched surface;
- said acid etched surface **extending from said lowermost end of said implant and into said cylindrical section of the threaded portion**; and
- said acid etched surface having a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns.

As noted above with respect to claims 51, 60, and 62, the combination of Haruyuki and Niznick fails because (i) Haruyuki and Niznick are directly contradictory to each other in several respects relative to the type of surface texture they teach, and (ii) Niznick teaches away from several aspects of the claimed acid-etched surface. Accordingly, for the reasons set forth above, the rejections of claims 68-71 and 73-75 should be reversed.

Claim 68 requires cylindrical and tapered sections and a self-tapping region within the tapered section. An acid-etched surface **extends from the lowermost end, through the self-tapping region, and into the cylindrical section**. The acid-etched surface has a substantially uniform array of irregularities having peak-to-valley heights no greater than about 10 microns. Niznick, on the other hand, does **not** teach an acid-etched surface extending from the lowermost end, through the self-tapping region, and into the cylindrical section. The middle threaded portion of Niznick's implant includes an extremely rough surface having peak-to-valley heights of greater than 25 microns. Of course, Niznick's roughen surface does **not** extend from the lowermost end of the implant, into the self-tapping region, and into the cylindrical section. As such, Niznick not only does not suggest the configuration of claims 68-71 and 73-75, but actually teaches away from it.

The Applicants respectfully request the reversal of the rejections of claims 68-71 and 73-75. Claims 68-71 and 73-75 are believed to be in a condition for allowance.

VI. The 103 Rejections of Claims 61, 67 and 72

The Applicants contend that claims 61, 67, and 72 are separately patentable for the reason that not all of the elements of claims 61, 67, and 72 are taught in Haruyuki or Niznick. Specifically, each of these dependent claims require that the second acid solution (which produces the acid-etched surface) is a mixture of sulfuric and hydrochloric acids. Haruyuki only discloses an HF and H_2O_2 solution. Haruyuki's two-step process differs from that of the Applicants' process and, more importantly, in the appearance of the resulting surfaces. Therefore, the claims that recite the acids used in the Applicants' two-step treatment should be patentable over Haruyuki. And, Niznick provides no suggestion whatsoever that would lead one skilled in the art to utilize the inventions set forth in dependent claims 61, 67, and 72.

VII. Dr. Porter's Declaration Establishing Secondary Evidence of Non-Obviousness

To overcome the obviousness rejections that were set forth by the Examiner, the Applicants submitted a Rule 132 Declaration from Dr. Porter that sets forth evidence of nonobviousness. That Declaration is set forth in Exhibit J and was submitted by the Applicants on April 29, 2002.

The Declaration establishes the nexus between the commercial Osseotite® surface and the claimed invention. The commercial Osseotite® surface is set forth in Exhibit A of this Declaration. Furthermore, several catalogs were included as Exhibit B, which show a myriad of examples of the overall screw-type structure of the dental implants that embody the Osseotite® surface. Without question, the dental implants with the Osseotite® surface that are discussed by Dr. Porter are covered by the pending claims that there the subject of this appeal.

Dr. Porter established a rapid increase in sales of implants having the Osseotite® surface relative to other implants. He further establishes evidence of **clinically-proven** enhanced osseointegration due to the Osseotite® surface. Most importantly, Dr. Porter establishes that numerous competitive companies, in attempting to sell their dental implants, compare their surfaces with the Osseotite® surface. These "me-too" competitive products and their associated

statements are competitive flattery indicating that the Osseotite® surface is the "gold standard" of implant surfaces.

In response to this Declaration, the Examiner states that "it is not clear that the claimed invention was used in the devices for sale. Therefore, there is no clear nexus of the claimed invention to the commercial success claimed." Office Action, July 16, 2002, p. 9. That simply is not true. Dr. Porter's Declaration discusses the Osseotite® surface is detail in paragraphs 3 and 5. That language tracks the language of the claims. And, Dr. Porter discloses the structure of these implants in the catalogs that are included in Exhibit B.

Next, the Examiner states "the sales data provided is for relative amounts of the two types of implant sold without any actual sales numbers so it hard to tell whether this overall sales dropped and the high percentages for Osseotite® surface was for lower sales volume." Office Action, July 16, 2002, p. 9. The Examiner's position may have merit if the relative sales percentages in paragraph 4 were fairly close, but this position is a stretch when considering the drastic increase of sales of implants with the Osseotite® surface. (i.e., an increase from 17% to 94% from 1996 to 2001). Furthermore, Dr. Porter states in paragraph 4 that the "sales of implants having the Osseotite® surface have rapidly increased since 1996," which is adverse to the Examiner's "relative amount" position set forth above.

In a further attempt to discount this Declaration, the Examiner states that the increase sales **"could"** have been due to an advertising bias. Yet, the Examiner was given examples of catalogs which showed different types of implants, including implants with the Osseotite® surface, that were available to clinicians. More importantly, the Examiner seemingly ignores Dr. Porter's statements in paragraphs 6-8 about the superior and clinically-proven enhanced osseointegration associated with the Osseotite® surface, which, of course, led to the increased sales.

Yet further, the Examiner states that there is no "side-by-side comparison of the like products." The Applicants are not aware of any requirement under MPEP 716.03 that suggests side-by-side comparison of like products for commercial success, but note that Dr. Porter provided a comparison of sales for all other dental implant's that lacked the Osseotite® surface in paragraph 4.

And, the Examiner apparently did not approve of the fact that the Declaration was signed by Dr. Porter, who was an employee of the assignee when he signed the declaration. Considering

that the commercial results of a product must be derived from within a corporation, the Applicants do not see any possibility for having a disinterested third party attest to facts related to internal sales figures of a corporation.

In summary, the Applicants spent considerable time developing a good-faith effort to demonstrate secondary evidence of non-obviousness. The Examiner gave no weight whatsoever to any of the commercial success evidence that was set forth therein, and summarily dismissed of the Declaration. The evidence of commercial success, and the other secondary evidence that was set forth in Dr. Porter's declaration, should have been considered by the Examiner and not summarily dismissed. This Declaration is yet another reason that the pending claims are not obvious.

8. CLAIMS APPENDIX – RULE 41.37(c)(1)(viii)

A clean copy of the claims 51 & 60-75 involved in the appeal is included in the Claims Appendix.

9. EVIDENCE APPENDIX – RULE 41.37(c)(1)(ix)

A copy of the evidence relied upon by the appellant is included in the Evidence Appendix. A list of evidence and where each was entered in the record is included in the Index to the Appendices.

10. RELATED PROCEEDINGS APPENDIX – RULE 41.37(c)(1)(x)

As there are no related proceedings, no information is provided in the Related Proceedings Appendix.

11. CONCLUSION

For at least the foregoing reasons, the final rejection of all the appealed claims should be reversed.

A check in the amount of $500.00 was submitted with the brief filed April 27, 2005, as required by 37 C.F.R. § 1.17(c). The Commissioner is authorized to charge any additional fees inadvertently omitted that may be required (except the issue fee) now or during the pendency of this application to JENKENS & GILCHRIST, P.C. Deposit Account No. 10-0447(47168-00035USC1).

Respectfully submitted,

Date: Aug. 12, 2005

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Statement of Support	
Amendment submitted with Appeal Brief	A
Haruyuki, cited by the Examiner on March 26, 2003. The English translation of Haruyuki was provided by the Patent Office. The photographs at the end of the Exhibit B are from the Japanese Patent Office, which were submitted in in the Amendment dated June 26, 2003.	B
U.S. Patent No. 4,826,434 (Krueger) cited by the Examiner	C
U.S. Patent No. 5,571,017 (Niznick) cited by the Examiner	D
Final Office Action Mailed July 23, 2004	E
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Specification Prepared for this Appeal Brief	G
A selection of photomicrographs from the declaration by Dr. Prabbu Gubbi provided in Exhibit I (below). This group of photographs was combined for purposes of this brief, but each was entered by the Examiner in the Gubbi declaration. Their location is indicated adjacent each set of photographs.	H
A declaration under 37 C.F.R. 1.132 by Dr. Prabbu Gubbi was accompanied by an amendment mailed June 26, 2003 entered by the Examiner on June 30, 2003. His response was contained in an Office Action mailed October 7, 2003.	I
A. Osseotite SEM and 3-D Surface Map/Stage I HF etch and Stage II etch $HC1+H_2SO_4$	
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A declaration under 37 C.F.R. 1.132 by Dr. Stephen S. Porter showing commercial success of Osseotite® dental implants. This declaration accompanied an amendment mailed April 22, 2002 and was entered by the Examiner. His response was contained in the final Office Action mailed July 16, 2002.	J
Related Proceedings Appendix	

Claims On Appeal

Claims 1-50 (Cancelled)

51. A dental implant made of titanium metal, comprising:

a smooth head portion for receiving a dental restoration component;

a lowermost end opposing said head portion;

a threaded portion for engaging bone between said head portion and said lowermost end; and

a roughened region for facilitating osseointegration with said bone located on said threaded portion and extending to said lowermost end of said implant, said roughened region being uniformly acid etched with a second acid solution after a native oxide layer had been removed by contact with a first acid solution with minimum consumption of said titanium metal to produce a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns.

Claims 52-59 (Cancelled)

60. A titanium metal dental implant of Claim 51, wherein said first acid solution is aqueous hydrofluoric acid.

61. A titanium metal dental implant of Claim 51, wherein said second acid solution is a mixture of sulfuric and hydrochloric acids.

62. A titanium metal dental implant of Claim 51, wherein said irregularities include cone-shaped elements.

63. A titanium dental implant, comprising:

a head portion for receiving a dental restoration component, said head portion including a non-rotational feature for engaging said dental restoration component, said head portion having a smooth machined surface;

a lowermost end opposing said head portion; and

a threaded portion having continuous thread turns and being located between said head portion and said lowermost end, said threaded portion including a self-tapping region adjacent to said lowermost end, said threaded portion having an acid-etched surface for facilitating osseointegration with said bone, said acid-etched surface extending to said lowermost end of said implant and within said self-tapping region, said acid-etched surface being produced on said threaded portion after a native oxide layer has been removed from said threaded surface, said acid-etched surface having a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns, said irregularities including cone-shaped elements.

64. The implant of claim 63, said acid-etched surface is located on said threaded portion below the first uppermost turn of said threaded portion.

65. The implant of claim 63, wherein said native oxide is removed by a first acid solution after which the resulting surface is etched with a second acid solution to create said acid-etched surface.

66. The implant of claim 65, said first acid solution is aqueous hydrofluoric acid.

67. The implant of claim 66, wherein said second acid solution is a mixture of sulfuric and hydrochloric acids.

68. A titanium dental implant, comprising:

a head portion for receiving a dental restoration component, said head portion including a non-rotational feature for engaging said dental restoration component;

a lowermost end opposing said head portion; and

a threaded portion having continuous thread turns and being located between said head portion and said lowermost end, said threaded portion including a cylindrical section and a tapered section immediately adjacent to said lowermost end, said

cylindrical section being longer than said tapered section, said tapered section including a self-tapping region that extends to said lowermost end, said threaded portion having an acid-etched surface for facilitating osseointegration with said bone, said acid-etched surface extending from said lowermost end and into said cylindrical section of said threaded portion, said acid-etched surface being produced on said threaded portion after a native oxide layer has been removed from said threaded portion, said acid-etched surface having a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns, said irregularities including cone-shaped elements.

69. The implant of claim 68, said acid-etched surface extends from said lowermost end to at least an uppermost turn of said threaded portion.

70. The implant of claim 68, wherein said native oxide is removed by a first acid solution after which the resulting surface is etched with a second acid solution.

71. The implant of claim 70, said first acid solution is aqueous hydrofluoric acid.

72. The implant of claim 70, wherein said second acid solution is a mixture of sulfuric and hydrochloric acids.

73. The implant of claim 68, further including a neck portion between said head portion and said threaded portion.

74. The implant of claim 73, wherein said neck portion is a smooth machined surface, said head portion having a smooth machined surface;

75. The implant of claim 68, wherein said head portion has a smooth machined surface.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Number.	:	09/237,605	Confirmation Number	: 7280
Applicants	:	Richard J. Lazzara		
Filed	:	January 25, 1999		
Title		Infection-Blocking Dental Implant		
TC/A.U.	:	3738		
Examiner	:	Paul B. Prebilic		
Docket Number	:	47168-00035USC1		
Customer Number	:	30223		

AMENDMENT UNDER 37 C.F.R. 41.33(b)(1)

MAIL STOP APPEAL BRIEF - PATENTS
U.S. PATENT AND TRADEMARK OFFICE
COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

CERTIFICATE OF MAILING
37 C.F.R. 1.8

I hereby certify that this paper is being deposited with the U.S. Postal Service as First Class Mail in an envelope addressed to: Mail Stop Appeal Brief-Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date indicated below:

_____
Date Signature

Sir:

This amendment is proposed to the subject application, now under appeal.

Amendments to the Claims are provided in the Listing of Claims which begins on page 2 of this paper.

Remarks begin on page 6 of this paper.

Amendments to the Claims

Claims 1-50 (Cancelled)

51. (Previously Presented) A dental implant made of titanium metal, comprising:

a smooth head portion for receiving a dental restoration component;

a lowermost end opposing said head portion;

a threaded portion for engaging bone between said head portion and said lowermost end; and

a roughened region for facilitating osseointegration with said bone located on said threaded portion and extending to said lowermost end of said implant, said roughened region being uniformly acid etched with a second acid solution after a native oxide layer had been removed by contact with a first acid solution with minimum consumption of said titanium metal to produce a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns.

Claims 52-59 (Cancelled)

60. (Previously Presented) A titanium metal dental implant of Claim 51, wherein said first acid solution is aqueous hydrofluoric acid.

61. (Previously Presented) A titanium metal dental implant of Claim 51, wherein said second acid solution is a mixture of sulfuric and hydrochloric acids.

62. (Previously Presented) A titanium metal dental implant of Claim 51, wherein said irregularities include cone-shaped elements.

63. (Previously Presented) A titanium dental implant, comprising:

a head portion for receiving a dental restoration component, said head portion including a non-rotational feature for engaging said dental restoration component, said head portion having a smooth machined surface;

a lowermost end opposing said head portion; and

a threaded portion having continuous thread turns and being located between said head portion and said lowermost end, said threaded portion including a self-tapping region adjacent to said lowermost end, said threaded portion having an acid-etched surface for facilitating osseointegration with said bone, said acid-etched surface extending to said lowermost end of said implant and within said self-tapping region, said acid-etched surface being produced on said threaded portion after a native oxide layer has been removed from said threaded surface, said acid-etched surface having a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns, said irregularities including cone-shaped elements.

64. (Previously Presented) The implant of claim 63, said acid-etched surface is located on said threaded portion below the first uppermost turn of said threaded portion.

65. (Previously Presented) The implant of claim 63, wherein said native oxide is removed by a first acid solution after which the resulting surface is etched with a second acid solution to create said acid-etched surface.

66. (Previously Presented) The implant of claim 65, said first acid solution is aqueous hydrofluoric acid.

67. (Previously Presented) The implant of claim 66, wherein said second acid solution is a mixture of sulfuric and hydrochloric acids.

68. (Previously Presented) A titanium dental implant, comprising:

a head portion for receiving a dental restoration component, said head portion including a non-rotational feature for engaging said dental restoration component;

a lowermost end opposing said head portion; and

a threaded portion having continuous thread turns and being located between said head portion and said lowermost end, said threaded portion including a cylindrical section and a tapered section immediately adjacent to said lowermost end, said cylindrical section being longer than said tapered section, said tapered section including a self-tapping region that extends to said lowermost end, said threaded portion having an acid-etched surface for facilitating osseointegration with said bone, said acid-etched surface extending from said lowermost end and into said cylindrical section of said threaded portion, said acid-etched surface being produced on said threaded portion after a native oxide layer has been removed from said threaded portion, said acid-etched surface having a substantially uniform array of irregularities having peak-to-valley heights not greater than about 10 microns, said irregularities including cone-shaped elements.

69. (Previously Presented) The implant of claim 68, said acid-etched surface extends from said lowermost end to at least an uppermost turn of said threaded portion.

70. (Previously Presented) The implant of claim 68, wherein said native oxide is removed by a first acid solution after which the resulting surface is etched with a second acid solution.

71. (Previously Presented) The implant of claim 70, said first acid solution is aqueous hydrofluoric acid.

72. (Previously Presented) The implant of claim 70, wherein said second acid solution is a mixture of sulfuric and hydrochloric acids.

73. (Previously Presented) The implant of claim 68, further including a neck portion between said head portion and said threaded portion.

74. (Previously Presented) The implant of claim 73, wherein said neck portion is a smooth machined surface, said head portion having a smooth machined surface;

75. (Previously Presented) The implant of claim 68, wherein said head portion has a smooth machined surface.

REMARKS

The accompanying brief assumes that the amendment proposed above will be admitted. The Applicants have chosen to simplify the issues in this appeal by canceling Claims 11-16 and 57-59, directed generally to implants. Since the owner of the pending application is in the dental implant industry, the remaining claims, directed to dental implants, are retained after amendment and would remain on appeal.

The Applicants request that the amendments be admitted in order to better focus the issues in this appeal. The assistance of Ms. Frances Han of the Board of Patent Appeals and Interferences with regard to this amendment is appreciated.

Respectfully submitted,

8/11/05
Date

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[Translator's Note. An amendment to this document was filed on 5 July 1990. This amendment has two effects. First, it replaces the entire as-filed section entitled, "4. Brief Description of the Drawings", with amended text. Second, it replaces the entire as-filed set of photographs (Figures 1 to 9) with another set of photographs. I have seamlessly incorporated the amendments into the following translation.]

SPECIFICATION

1. Title of the Invention

Titanium or titanium alloy biorepair member and method for treating the surface thereof

2. Claims

1. Titanium or titanium alloy biorepair member wherein at least the surface of the embedded portion of the titanium or titanium alloy biorepair member is provided by means of acid treatment with irregularly shaped microscopic depressions having an average diameter of 1 to 10 μm and an average depth of 0.5 to 5 μm.

2. Method for treating the surface of the titanium or titanium alloy biorepair member according to Claim 1, wherein the aforesaid acid treatment comprises a pretreatment in which the surface of the aforesaid embedding portion is dipped in 1 to 6 weight% aqueous hydrofluoric acid (HF) solution for 30 seconds to 3 minutes followed by a posttreatment comprising dipping for 10 to 60 seconds in an aqueous mixed solution of 1 to 6 weight% aqueous hydrofluoric acid solution and 1 to 10 weight% hydrogen peroxide (H_2O_2) solution.

3. Detailed Description of the Invention

Technical Field

This invention relates to the titanium and titanium alloy biorepair members used in medicine for, e.g., dental surgery and surgery. More particularly, this invention relates to improvements in implant members, for example, artificial joints, bone fixation devices, artificial bone, artificial dental roots, false teeth, and so forth.

Prior Art

The initial adhesion across the interface between living tissue and the surface of the aforesaid biorepair members when embedded in the tissue varies as a function of the properties of the surface of the member. When, for example, the surface is a mirror surface lacking elevations and depressions, the bonding strength to bone is weak and the member will not be adequately supported by the tissue. When on the other hand the surface is a rough surface presenting elevations and depressions, the bone will infiltrate into and grow in the microvalleys, which generates a microanchoring effect that results in strong support of the member within the bone. Furthermore, the

necessary initial adhesive strength develops relatively rapidly in this case. Against this background, technology for roughening the surface of the repair member has already entered into use. The most general roughening methods have been mechanical roughening of the bare surface and roughening by plasma metal spray. One drawback to the mechanical processes is biotissue contamination by the foreign metal that transfers to the member surface from the metal processing tools (cutting, polishing, etc.). The plasma metal spray processes are compromised by their operational complexity and high cost. In an attempt to deal with these issues, Japanese Patent Application Laid Open [Kokai or Unexamined] Number Sho 55-120864 [120,864/1980] has proposed the formation of ultrafine, 10 nm to 1,000 nm (0.01 μm to 1 μm) pores in the surface of metal repair members. However, the processing technology for forming these ultrafine pores is very costly, tedious, and complex. Moreover, the bonding force with cells is still not always adequate.

Problems to Be Solved by the Invention

This invention was developed in order to solve the problems described above. In order to establish a microanchoring effect between bone tissue and the surface of a Ti or Ti alloy biorepair member, a roughened structure must be formed that provides an excellent initial adhesion between cells and the surface of the member. Another object of the present invention is a biorepair member in which such a roughened structure can be fabricated by a simple, highly productive, and inexpensive procedure and whose surface roughness can be easily adjusted. An additional object of the present invention is a method for treating the surface of the subject biorepair member.

Means Solving the Problems

The present invention relates to a titanium or titanium alloy biorepair member wherein at least the surface of the embedded portion of the titanium or titanium alloy biorepair member is provided by means of acid treatment with irregularly shaped microscopic depressions having an average diameter of 1 to 10 μm and an average depth of 0.5 to 5 μm. The invention additionally relates to a method for treating the surface of a titanium or titanium alloy biorepair member, wherein the aforesaid acid treatment comprises a pretreatment in which the surface of the aforesaid embedding portion is dipped in 1 to 6 weight% aqueous hydrofluoric acid (HF) solution for 30 seconds to 3 minutes followed by a posttreatment comprising dipping for 10 to 60 seconds in an aqueous mixed solution of 1 to 6 weight% aqueous hydrofluoric acid solution and 1 to 10 weight% hydrogen peroxide (H_2O_2) solution.

Function

The use of an aqueous hydrofluoric acid solution as the pretreatment functions to thoroughly remove the oxide film present on the surface of Ti and Ti alloy biorepair members and to remove the foreign metal contaminants picked

up during processing operations. In addition, the use of the specific conditions described above functions to provide a large number of irregularly shaped microscopic depressions with an average diameter of 1 to 10 μm and an average depth of 0.5 to 5 μm. Moreover, the depression size and depth can be changed, and hence the surface roughness can be adjusted, by varying the HF concentration and dipping time. The bases for specifying a range of 1 to 6 weight% for the HF concentration are as follows: pore sizes ≥ 1 μm cannot be reached at below 1%, while large pore sizes in excess of 10 μm are produced when 6% is exceeded. The adhesive strength to cells is low when the average pore size is below 1 μm. At pore sizes larger than 10 μm, the pore can be larger than the tissue cells, which are from 10 to 100 μm in size. As a result, the cells will stick at the bottom of the depressions and cannot straddle the ridges between depressions, leading to an inadequate adhesive strength. The bases for specifying an average depth in the range from 0.5 to 5 μm are as follows: the anchoring effect between the bone and biorepair member is low at an average depth below 0.5 μm; an average depth in excess of 5 μm, although providing a high anchoring effect, tends to result in the appearance of sharp spines and sharp edges at the ridge lines between depressions, which can cause tissue irritation (possibly a trigger for cancer). The bases for specifying a dipping time of 30 seconds to 3 minutes are as follow: the depressions are too shallow at below 30 seconds, which strongly impairs satisfactory removal of the contaminating layer present prior to treatment; the depressions become too deep at times in excess of 3 minutes, which leads to the formation of large numbers of sharp edges and sharp spines as described above.

Dipping in a mixed aqueous solution of HF and H_2O_2 in the posttreatment functions to smooth the sharp edges and sharp spines that appear at the microscopic depressions produced during the pretreatment. As the examples given below will show, the use of an aqueous solution of only H_2O_2 instead of the mixed aqueous solution is ineffective for smoothing these sharp edges and sharp spines. The bases for specifying a hydrogen peroxide concentration of 1 to 10 weight% are as follows: at below 1 weight% the effect is substantially identical to that of HF alone, i.e., inadequate removal of the sharp edges and spines; exceeding 10 weight% functions to increase the pore diameter and thus has a pronounced tendency to create new sharp edges and spines. The bases for specifying a dipping time of 10 to 60 seconds are as follows: inadequate effects are obtained at below 10 seconds, while times above 60 seconds cause the appearance of sharp edges and spines.

Examples

Working examples of the present invention and comparative examples are reported in Table 1 below.

Table 1.

sample no. and classification	nature of surface treatment	measurement results for surface roughness				results of analysis of the electron micrograph (the numerical values refer to the pore diameter of the depression (inside crosswise diameter))	results of visual inspection
		measurement distance = 0.25 mm		measurement distance = 0.80 mm			
		Rz (µm)	Rmax (µm)	Rz (µm)	Rmax (µm)		
Comparative Example 1	specimen prior to surface treatment	0.3	0.6	0.6	2.1	bruising, crevices, and occluded pores appeared on the polished surface	apparent mirror finish (some bruising)
Comparative Example 2	4% HF, 1 minute no posttreatment	1.3	2.9	2.4	3.5	large numbers of 2 µm ~ 3 µm pits are observed, sharp edges and sharp spines occur	silver gray (slightly yellowed)
Example 1	4% HF, 30 seconds posttreatment: 15 seconds, 4% HF + 8% H_2O_2	1.4	2.6	2.5	3.2	large numbers of 2 µm ~ 5 µm pits are observed, some sharp edges occur, sharp spines are absent	silver gray
Example 2	4% HF, 1 minute posttreatment: 15 seconds, 4% HF + 8% H_2O_2	1.3	2.6	2.4	3.3	large numbers of 2 µm ~ 5 µm pits are observed, sharp edges and sharp spines are absent	silver gray
Example 3	4% HF, 2 minutes posttreatment: 15 seconds, 4% HF + 8% H_2O_2	1.8	3.2	2.9	4.8	large numbers of 2 µm ~ 10 µm pits are observed, 1 ~ 3 µm small pits are seen in the large pits, sharp edges and sharp spines are absent	silver gray
Example 4	2% HF, 1 minute posttreatment: 15 seconds, 4% HF + 8% H_2O_2	1.4	3.4	2.4	3.4	large numbers of 1 µm ~ 3 µm pits are observed, some sharp edges are observed	silver gray

(Table 1 is continued on the next page)

Table 1. Continued from previous page.

sample no. and classification	nature of surface treatment	measurement results for surface roughness				results of analysis of the electron micrograph (the numerical values refer to the pore diameter of the depression (inside crosswise diameter))	results of visual inspection
		measurement distance = 0.25 mm		measurement distance = 0.80 mm			
		Rz (μm)	Rmax (μm)	Rz (μm)	Rmax (μm)		
Example 5	8% [sic] HF, 1 minute posttreatment: 15 seconds, 4% HF + 8% H_2O_2	2	4.2	3	4.5	large numbers of 2 μm ~ 10 μm pits are observed, 2 ~ 5 μm small pits are seen in the large pits, some sharp edges and sharp spines are seen	silver gray
Experimental Example 1	4% HF, 1 minute posttreatment: 1 minute, 8% H_2O_2	1	1.8	2	3.3	large numbers of 0.5 μm ~ 4 μm pits are observed, sharp edges and also sharp spines occur	silver gray (slightly yellowed)
Experimental Example 2	4% HF, 1 minute posttreatment: 15 seconds, 8% H_2O_2	1.1	1.9	2.6	3.6	large numbers of 0.5 μm ~ 4 μm pits are observed, sharp edges and also sharp spines occur	silver gray (slightly yellowed)

Notes to the table.

1. The measurement distance refers to the distance over which the measurement is taken along the length[1] of the sample.
2. Rz refers to the mean depression depth for 5 ridges and 5 valleys for a total of 10 depressions within the measurement distance.
3. Rmax refers to the maximum depression depth over the measurement distance.
4. Comparative Examples 1 and 2 refer to prior-art specimens.
5. Experimental Examples 1 and 2 cover the use of H_2O_2 by itself in the posttreatment.
6. The pore sizes of the depressions were determined using the appended electron micrographs.

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1 Translator's Note. Due to poor legibility, I cannot clearly determine if the measurement distance runs along the length or along the width of the sample.

The results in Table 1 will now be analyzed in the same order as in Table 1 with reference to the electron micrographs (abbreviated below simply as photographs) appended herewith.

(1) The specimen in Comparative Example 1 was an untreated specimen that presented with a mirror finish. As shown in Photograph 1,[2] it suffered from shot bruising and crevices (also from occluded pores although this is outside the area of the photograph) and thus was unacceptable in terms of adhesion to connective tissue.

(2) As shown in Photograph 2, the specimen afforded by HF treatment of the specimen of Comparative Example 1 presented a large number of pits as a result of the acid corrosion; however, the pore edges took the form of sharp edges (white ridge lines). This made this specimen unacceptable in terms of tissue irritation.

(3) In Example 1, the specimen was treated using one-half the HF treatment time of Comparative Example 2 and was then immersed in HF + H_2O_2 mixed solution. As shown in Photograph 3, in the resulting specimen the sharp edges have been largely eliminated (the white ridge lines have faded) and sharp spines are not present.

(4) In Example 2, the specimen was treated with HF using the same conditions as in Comparative Example 2 and was then treated with the mixed solution as in Example 1. As shown in Photograph 4, neither sharp edges nor sharp spines are present, and this example thus represents the best mode.

(5) In Example 3, the specimen was treated with HF for twice as long as in Example 2 and then treated with the mixed solution using the same conditions as in Example 2. As shown in Photograph 5, the pit diameters were approximately twice as large and small (1 ~ 3 μm) pits were observed in the large pits. Sharp edges and sharp spines were almost entirely absent.[3]

(6) The specimen in Example 4 was obtained using one-half the HF concentration of Example 3 and the same mixed solution treatment as in Example 3. As shown in Photograph 6, there is little variation in pore size. Some sharp edges and sharp spines are present, but not to a problematic degree.

(7) The specimen in Example 5 was obtained using twice the HF concentration as in Examples 1 to 3, but the same mixed solution treatment.

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2 Translator's Note. The pre-amendment electron micrographs were labelled Photographs 1-9, while the post-amendment micrographs are labelled Figures 1-9. The text, however, has not been amended to reflect this change.

3 Translator's Note. There is a slight conflict here in that the results for Example 3 in Table 1 state that the sharp edges and spines are absent, not "almost entirely absent". This conflict occurs in the Japanese source document itself and is not an artifact of the translation process.

As shown in Photograph 7, almost the same results were obtained as in Example 4.

(8) The specimen in Experimental Example 1 was prepared using an aqueous solution of H_2O_2 by itself as the posttreatment solution and using a posttreatment time of 1 minute. As demonstrated in Photograph 8, the resulting specimen had a diminished pore size and presented a large number of sharp edges and sharp spines.

(9) The specimen in Experimental Example 2 used the same posttreatment solution as in Experimental Example 1 while using a posttreatment time of 15 seconds. As shown in Photograph 9, the resulting specimen was substantially the same as in Experimental Example 1.

(10) The pore size (surface roughness) of the pits could be varied in Examples 1 to 5 by varying the HF concentration and dipping time.

The preceding observations can be summarized as follows:

a) The HF treatment causes acid corrosion of the smooth surface with the formation of a largenumber of pits. The ensuing posttreatment with a mixed HF + H_2O_2 solution smooths the pit edges, although a too low HF concentration tends to leave the sharp edges and sharp spines.

b) A posttreatment solution lacking HF and containing only H_2O_2 is ineffective for eliminating the sharp edges and sharp spines, although the reason for this remains unknown.

c) The pore size of the pits can be varied by varying the HF concentration and treatment time in the pretreatment.

d) When the posttreatment solution of the method according to the present invention is used, the silver gray color of the substrate remains completely unchanged, which provides an excellent appearance.

Effects of the Invention

As the preceding description has shown, the present invention can provide an excellent appearance and an excellent adhesive strength between connective tissue and the surface of the biorepair member. The present invention achieves these results by subjecting the embedding surface of a Ti or Ti alloy biorepair member to an acid treatment in order to provide thereon a large number of irregularly shaped microscopic depressions with an average diameter of 1 ~ 10 μm and an average depth of 0.5 to 5 μm. This acid treatment consists simply of an acid corrosion pretreatment using ordinary hydrofluoric acid and an ensuing posttreatment using ordinary hydrofluoric acid and hydrogen peroxide. This method is simple and highly productive and permits the surface roughness to be adjusted by varying the HF concentration and treatment time during the pretreatment step.

4. Brief Description of the Drawings

Figure 1 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Comparative Example 1 (no treatment, mirror surface as presented). Figure 2 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Comparative Example 2. Figure 3 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Example 1. Figure 4 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Example 2. Figure 5 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Example 3. Figure 6 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Example 4. Figure 7 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Example 5. Figure 8 contains an electron micrograph (2,000×) of the structure of the crystals on the surface in Experimental Example 1. Figure 9 contains an electron micrograph of the structure of the crystals on the surface in Experimental Example 2.

Toho Titanium Co. Ltd. Kokai Hei 3-146679

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⑤④発明の名称　チタンもしくはチタン基合金製生体修復部材及びその表面処理法

⑳特　願　平1－282570

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明　細　書

1．発明の名称

チタンもしくはチタン基合金製生体修復部材及びその表面処理法

2．特許請求の範囲

1．チタンもしくはチタン基合金製生体修復部材の少なくとも埋入部表面を酸処理によって平均孔径1～10μm、平均深さ0.5～5μmの不定形の微細な凹みを設けて成るチタンもしくはチタン基合金製生体修復部材。

2．上記酸処理が前処理として1～6wt%濃度のフッ化水素酸（HF）水溶液に上記埋入部表面を30秒～3分間浸漬処理をすること、続いて後処理として1～6wt%濃度のフッ化水素酸水溶液と1～10wt%濃度の過酸化水素（H_2O_2）液との混合水溶液に10～60秒浸漬処理をすることよりなる請求項1記載のチタンもしくはチタン基合金製生体修復部材の表面処理法。

3．発明の詳細な説明

（産業上の利用分野）

本発明は歯科、外科等の医療分野に於て用いるチタンもしくはチタン基合金製生体修復部材、とりわけインプラント部材、例えば人工関節、骨接合部材、人工骨、人工歯根、義歯等の改良に関する。

（従来の技術）

生体内に埋設される上記生体修復部材の表面と生体組織との界面に於ける初期接着は部材表面の性状によって異なる。即ち、凹凸のない鏡面の場合は骨との結合力が低く当該組織による部材の支持が不充分である。之に対して凹凸をもった粗面の場合は骨が細隙内に侵入・増殖して微少投錨効果（マイクローアンカーリング）を得ることができ、部材の骨内支持が強力なものとなる。また比較的早期に必要な初期接着強度が得られる。この意に於て修復部材の表面に粗面加工を行なう技術は従来より採用されてきた所である。すなわち、最も一般的な方法として機械加工による素肌のまゝか部材の表面にプラズマ溶射による粗面加工を

行なうことがなされてきた。しかし、前者の場合の欠点としては金属製加工具（切削、研磨用等）からの異種金属が部材表面に転移して生体組織を汚染することが挙げられ、後者の場合は加工工程が複雑で加工費も嵩む。このような点に鑑み特開昭５５－１２０８６４によって金属製修復部材表面に１０ｎｍ～１０００ｎｍ（０．０１μｍ～１μｍ）の超微細毛孔を形成する試みが提案されたが、このような超微細毛孔を形成する加工技術は極めて面倒複雑でコスト高となり、また細胞との結合力も必ずしも充分ではない、と云う問題をなお残している。

（発明が解決しようとする課題）

本発明は凡そ上記問題点の除去に鑑みなされたもので、チタンもしくはチタン基合金製生体修復部材の表面と骨組織との微少投錨効果を確立するためには細胞の初期部材の表面接着が優れた粗面構造を作成する必要がある。しかもその粗面構造の作成方法は簡易で生産性が良く安価である上に面粗度をコントロールし易い生体修復部材並びにその表面処理法をこゝに提供せんとするものである。

（課題を解決するための手段）

本発明はチタンもしくはチタン基合金製生体修復部材の少なくとも埋入部表面を酸処理によって平均孔径１～１０μｍ、平均深さ０．５～５μｍの不定形の微細な凹みを設けて成るチタンもしくはチタン基合金製生体修復部材に関する。本発明はまた、上記酸処理が前処理として１～６ｗｔ％濃度のフッ化水素酸（ＨＦ）水溶液に上記埋入部表面を３０秒～３分間浸漬処理をすること、続いて後処理として１～６ｗｔ％濃度のフッ化水素酸水溶液と１～１０ｗｔ％濃度の過酸化水素（H_2O_2）液との混合水溶液に１０～６０秒浸漬処理をすることよりなるチタンもしくはチタン基合金製生体修復部材の表面処理法に関する。

（作用）

前処理としてのフッ化水素酸（ＨＦ）水溶液はチタンもしくはチタン基合金製生体修復部材の表面酸化膜はもとより加工工程中に受けた異種金属の汚染を十分に洗浄化し得ると共に後記の限定条件のものを用いることによって平均孔径１～１０μｍ、平均深さ０．５～５μｍの不定形の微細な凹みを多設することができる。またＨＦ濃度、浸漬時間の調整により上記孔径、深さを可変して面粗度をコントロールすることが可能である。ＨＦの濃度を１～６ｗｔ％の範囲のものとするのは１％未満の場合は孔径が１μｍに達せず、６％を超えると逆に大きくなって１０μｍを超えてしまうからである。而して平均孔径が１μｍ未満の場合は細胞の接着力が低くなり、１０μｍを超えると組織細胞（その大きさは１０～１００μｍと云われている）より大きくなる場合があり、この場合は細胞が凹みの谷底に付着して山部を跨がないので接着強度が十分に得られないと云う理由による。平均深さが０．５～５μｍの範囲である理由は０．５μｍを下廻る時は骨と部材間における投錨効果が減少し、５μｍを上廻る場合は投錨力はあがるものの凹みの稜線部にシャープエッジや尖鋭とげが出来易く、組織刺戟性（発展的には発癌のトリガーとなる）が出てくるからである。浸漬時間を３０秒～３分としたのは、３０秒未満の場合は凹みの深さが浅すぎて処理前の汚染層を十分に除去しきれない傾向があり、３分を超えると凹みの深さが深くなりすぎて前記したようにシャープエッジや尖鋭とげが多くなるためである。

後処理としてのＨＦ及びH_2O_2混合水溶液浸漬は前処理によって形成された微細な凹みに発現するシャープエッジ、尖鋭とげをなめらかにする作用をなす。後の実施例でも述べる如くこの混合水溶液に代ってH_2O_2水溶液単味の場合はシャープエッジ、尖鋭とげの平滑化に役立たない。H_2O_2の濃度を１～１０ｗｔ％としたのは、１ｗｔ％未満の場合はＨＦ単味と同じ程度の効果、即ちシャープエッジ、尖鋭とげの除去作用が不充分であり、１０ｗｔ％を超えると孔径を大としてしまい新しいシャープエッジ、尖鋭とげが発現し易い傾向となるからである。浸漬時間を１０～６０秒としたのは１０秒に満たないときは効果が不充分であり、逆に６０秒より長くなるとシャープエッジ、尖鋭

とげが現われてくるからである。

（実施例）

以下に本発明の実施例を比較例及び実験例ともども表1に示す。

（以下余白）

（表 1）

試料No及び属性	表面処理内容	表面粗さ測定結果				電子顕微鏡観察結果〔なお数値は凹みの孔径（発し波し内径）を示す〕	目視観察結果
		測定距離0.25㎜		測定距離0.80㎜			
		Rz(μm)	Rmax(μm)	Rz(μm)	Rmax(μm)		
比較例1	表面処理前の試料	0.3	0.6	0.6	2.1	研削面に打痕、クレバス、あるいは陥没された穴がある。	一見鏡面（多少打痕有り）
比較例2	4%HF 1分間 後処理なし	1.3	2.9	2.4	3.5	2μm～3μmのピットが多く見られるが、シャープエッジや尖鋭とげがある。	銀灰色（やや黄ばみ）
実施例1	4%HF 30秒間、4%HF＋8%H_2O_2 後処理 15秒間	1.4	2.6	2.5	3.2	2μm～5μmのピットが多く見られ、シャープエッジが若干あるが尖鋭とげはない。	銀白色
実施例2	4%HF 1分間、4%HF＋8%H_2O_2 後処理 15秒間	1.3	2.6	2.4	3.3	2μm～5μmのピットが多く見られ、シャープエッジや尖鋭とげはない。	銀白色
実施例3	4%HF 2分間、4%HF＋8%H_2O_2 後処理 15秒間	1.8	3.2	2.9	4.8	2μm～10μmのピットが多く見られ大きなピットの中に1~3μmの小さなピットが見られる。シャープエッジ、尖鋭とげはない	銀白色
実施例4	2%HF 1分間、4%HF＋8%H_2O_2 後処理 15秒間	1.4	3.4	2.4	3.4	1μm～3μmのピットが多く見られシャープエッジが若干みられる。	銀白色
実施例5	8%HF 1分間、4%HF＋8%H_2O_2 後処理 15秒間	2	4.2	3	4.5	2μm～10μmのピットが多く見られ、大きなピットの中に2~5μmの小さなピットが見られる。シャープエッジ、尖鋭とげは若干みられる。	銀白色
実験例1	4%HF 1分間、8%H_2O_2 後処理 1分間	1	1.8	2	3.3	0.5μm～4μmのピットが多く見られるが、シャープエッジがある。尖鋭とげもある。	銀灰色（やや黄ばみ）
実験例2	4%HF 1分間、8%H_2O_2 後処理 15秒間	1.1	1.9	2.6	3.6	0.5μm～4μmのピットが多く見られるが、シャープエッジがある。尖鋭とげもある。	銀灰色（やや黄ばみ）

(註)
1．測定距離とは試料の幅方向についての測定に関与した距離を示す。
2．Rzとは各測定距離内の凹みの山部を5ケ、谷部を5ケ、合せて10ケの凹みの深さの平均値を示す。
3．Rmaxとは各測定距離内の凹みの深さの最大値を示す。
4．比較例1，2は従来公知の技術の試料を示す。
5．実験例1，2は後処理としてH_2O_2単独使用の例を示す。
6．凹みの孔径は添付の電子顕微鏡写真より割り出したものである。

表１の結果を添付図面代用の電子顕微鏡写真（以下単に写真と略す）を参照しながら表１の順について説明する；

（１）鏡面仕上げのまゝの無処理の比較例１のものは写真１の如くショット打痕、クレバス（この他写真外であるが隠蔽穴）があり、結合組織の接着を考慮した際不適である。

（２）比較例１のものをＨＦ処理をしたものは写真２の如く酸蝕による多くのピットが発現するが、孔縁がシャープエッジ（白い稜線部）をなしており組織への刺戟性を考慮する時、望ましくない。

（３）実施例１の如く比較例２のＨＦ処理時間を1/2とし、これに続いてＨＦ＋H_2O_2の混合液に浸漬したものは写真３のようにシャープエッジが大部分とれて（白い稜線部がボヤけてきている）尖鋭とげはない。

（４）実施例２の如く比較例２のＨＦ処理と同一条件とし続いて上記混合液処理を行なったものは写真４の如くシャープエッジ、尖鋭とげは不在でベストモードを示している。

（５）ＨＦ処理を実施例２の２倍時間かけて実施例２と同一の混合液処理を行なった実施例３のものは写真５の如くピット孔径が約２倍に増大すると共に大きなピットの中に小さな（１～３μｍ）のピットが認められシャープエッジ、尖鋭とげが殆どない。

（６）ＨＦの濃度を前実施例の1/2とし同じ混合液処理をした実施例４のものは写真６に示す如く孔径の変化は小さい。シャープエッジ、尖鋭とげは若干あるがこの程度では心配に値しない。

（７）ＨＦの濃度を実施例１～３の２倍にし混合液処理を同じにした実施例５のものは写真７の如く概ね実施例４のものと同じ所見である。

（８）後処理液としてH_2O_2水溶液単独を用い後処理時間を１分とした実験例１のものは写真８の如く孔径が減少しこれと共に多くのシャープエッジ、尖鋭とげの発現がみられる。

（９）実験例１の後処理液を用い後処理時間を１５秒とした実験例２のものは写真９より明らかなように実験例１とほゞ同様な所見となっている。

（10）実施例１～５に於て、ＨＦの濃度もしくは浸漬時間を変えることによってピットの孔径（面粗度）を変えることが出来る。

以上を更にまとめると；

ａ）ＨＦ処理によって平滑な表面が酸蝕されて多数のピットが形成され、続いてＨＦとH_2O_2との混合液による後処理によって上記ピットの稜線が平滑にされるも、ＨＦの濃度が低過ぎてもくシャープエッジ、尖鋭とげが復元する傾向にある。

ｂ）後処理液としてＨＦを含まずH_2O_2単独の場合は何故かシャープエッジ、尖鋭とげの消去に役立たない。

ｃ）前処理のＨＦの濃度、処理時間の調整により、ピットの孔径を変えられる。

ｄ）本発明法の後処理液を用いた場合、銀灰色の素地色は全て銀白色に輝いて見ばえが良好である。

（発明の効果）

本発明は叙述より理解されたように、チタンもしくはチタン基合金製生体修復部材の埋入部表面に酸処理による平均孔径１～１０μｍ、平均深さ０．５～５μｍの不定形の微細な凹みを多設することによって、結合組織の当該表面に対する接着強度が優れ且つ見ばえの良い特徴を付与し得たものであり、またその酸処理も前処理として通常のフッ化水素酸による酸蝕を行ない、これに後続して後処理として同フッ化水素酸と過酸化水素との混合液による処理をすればよいので方法的にも簡易で生産性がよく且つ前処理としてのＨＦの濃度もしくは処理時間を変えることにより表面粗さを変えることが出来る…等の優れた利益がある。

４．図面の簡単な説明

添付図面代用写真１～９は表１の試料の順に対応する生体修復部材の表面性状を示す電子顕微鏡写真を示す。

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写真 1 Comp. Ex. Unetched

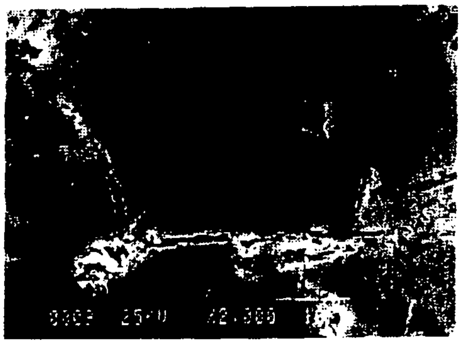

写真 2 Comp. Ex. 2 4% HF, 1 min

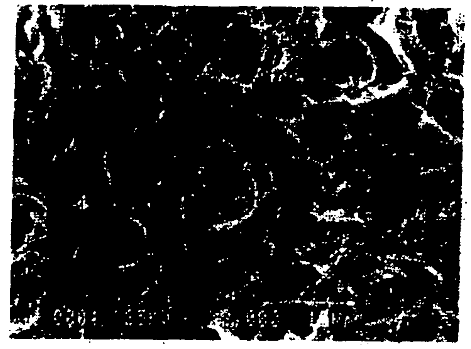

写真 3 Ex. 1 4% HF 30 sec. 4% HF / 8% H_2O_2 15 sec

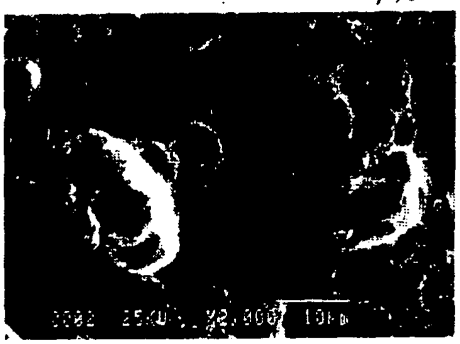

写真 4 Ex. 2 4% HF 1 min 4% HF / 8% H_2O_2 15 sec

写真 5 Ex. 3 4% HF 2 min. 4% HF / 8% H_2O_2 15 sec

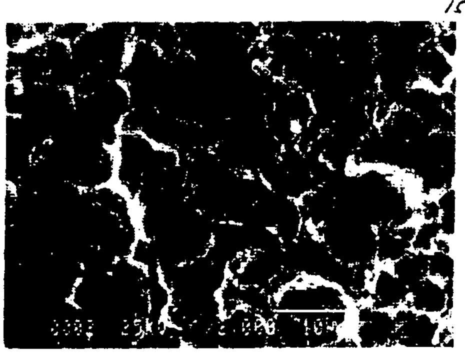

写真 6 Ex. 4 2% HF 1 min 4% HF / 8% H_2O_2 15 sec

7

(Photo cut off, but is on file)

Ex. 5

8% HF 1 min

4% HF / 8% H_2O_2, 15 sec

8

Exp. 1

4% HF 1 min

8% H_2O_2 1 minute

手続補正書（方式）

平成２年7月5日

写　真　9

Exp 2
4% HF 1min
8% HNO3 15sec

特許庁長官　吉田　文毅　殿

1．事件の表示

平成１年特許願第２８２５７０号

2．発明の名称

チタンもしくはチタン基合金製生体修復部材及びその表面処理法

3．補正をする者

事件との関係　特許出願人

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代表者　八　島　舜　一

4．代理人　〒５５０

住所　大阪市西区京町堀1-12-14(天真ビル)

氏名　弁理士(6235)　松　野　英　彦

☎ 06-443-4990・7559

5．補正命令の日付

平成２年２月２７日（発送日）

6．補正の対象

明細書の「図面の簡単な説明」の欄及び「図面」．

7．補正の内容

（１）「図面の簡単な説明」を別紙の通り補正する．

（２）別紙の通り図面の連続番号を「第１図～第９図」と補正する．

8．添付書類の目録

（１）図面の簡単な説明（補正）　１通

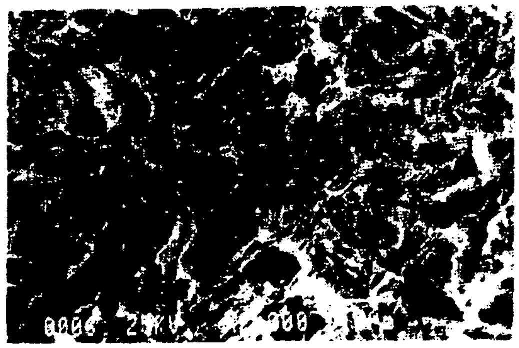
（２）図面「第１図～第９図」（補正）　１通

－以上－

4．図面の簡単な説明（補正）

第１図は鏡面仕上げのままの無処理の比較例１の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第２図は比較例２の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第３図は実施例１の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第４図は実施例２の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第５図は実施例３の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第６図は実施例４の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第７図は実施例５の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第８図は実験例１の表面の結晶の構造を示す電子顕微鏡写真（×２０００）、第９図は実験例２の表面の結晶の構造を示す電子顕微鏡写真（×２０００）である．

第 9 図



Exp. 2
4% HF, 1 min
8% H_2O_2, 15 sec

第　1　図

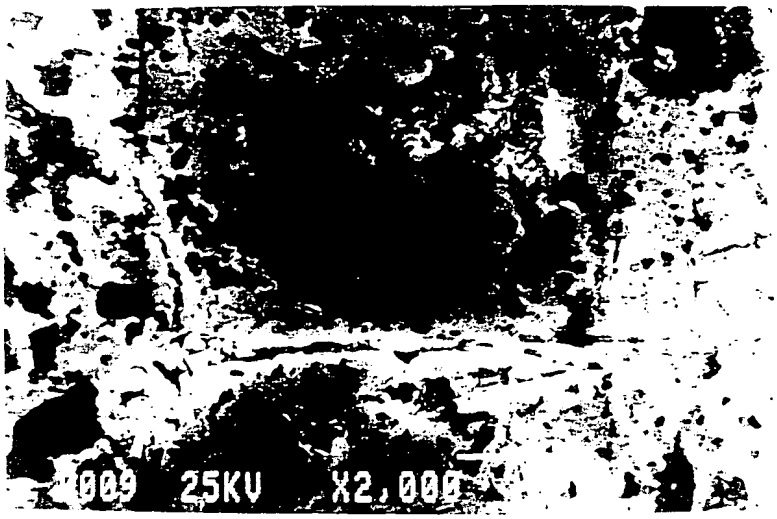


FIG. 1

第　2　図

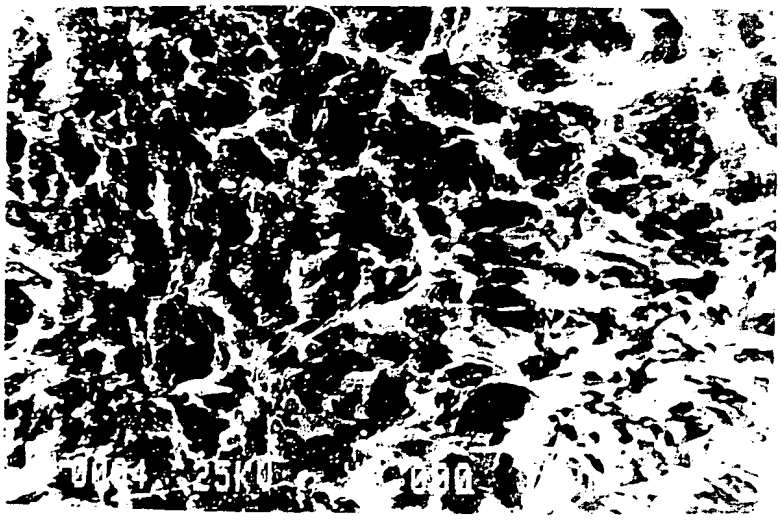


FIG. 2

第　3　図

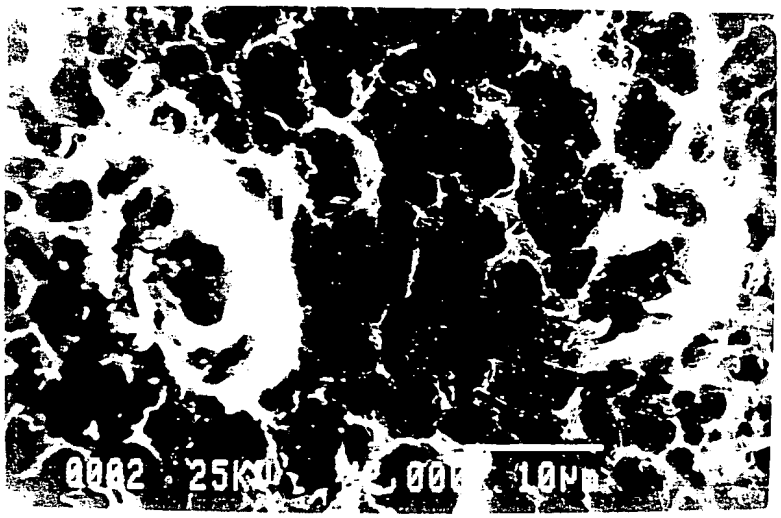


FIG. 3

第　4　図

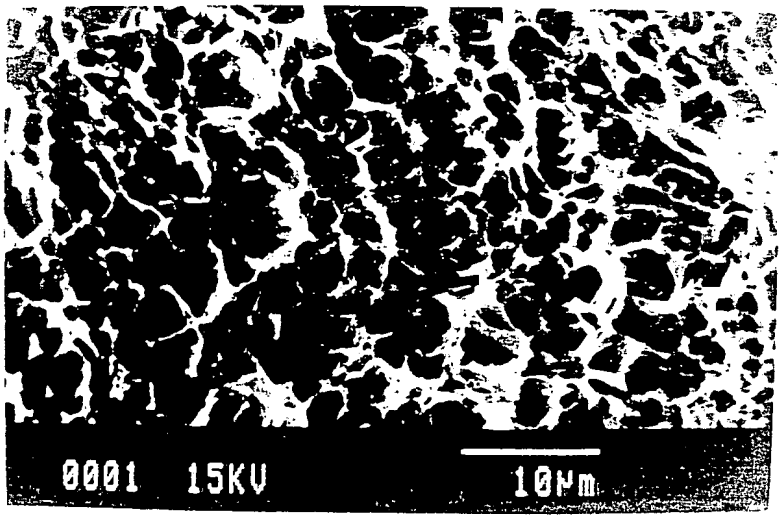


FIG. 4

第　5　図

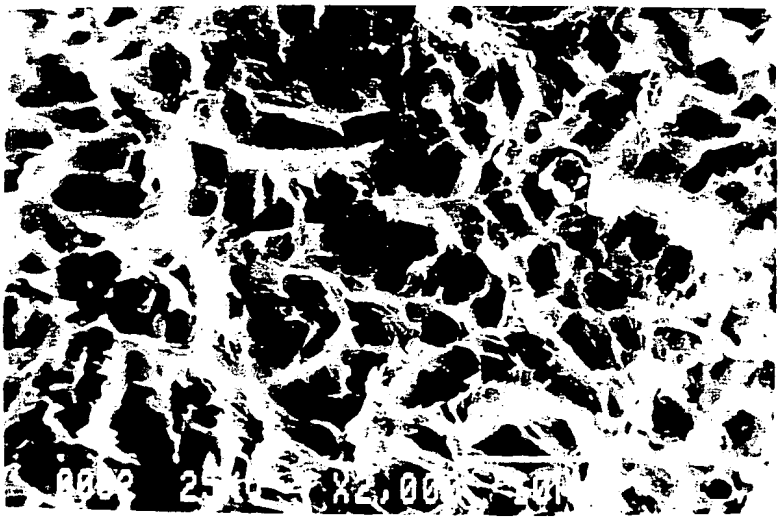


FIG. 5

第　6　図

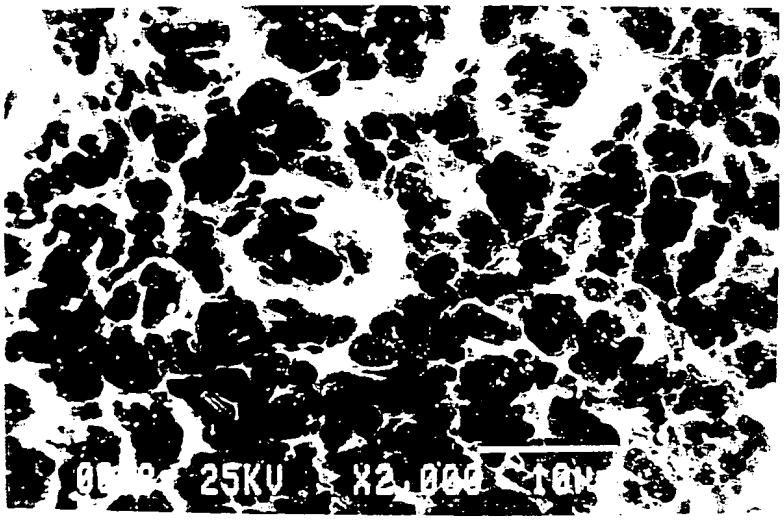


FIG. 6

第　7　図

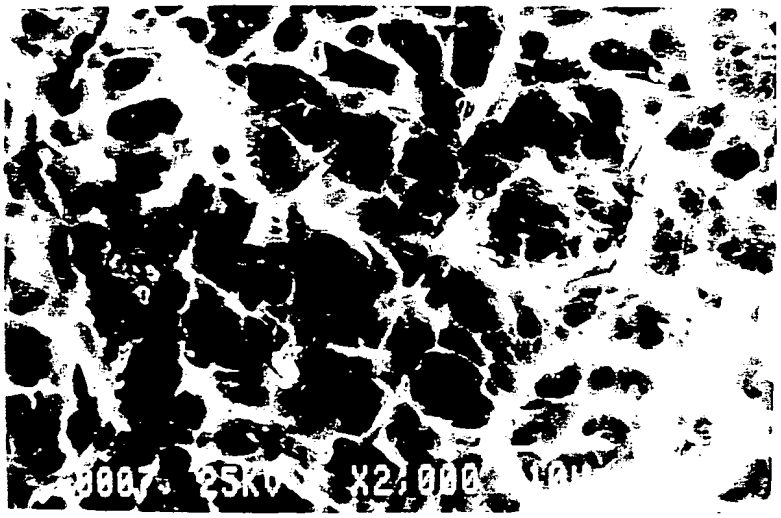


FIG. 7

第　8　図

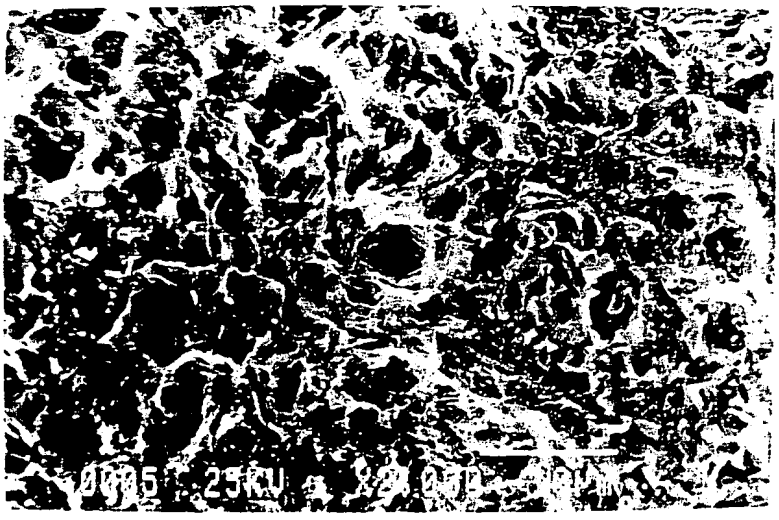


FIG. 8

第　9　図

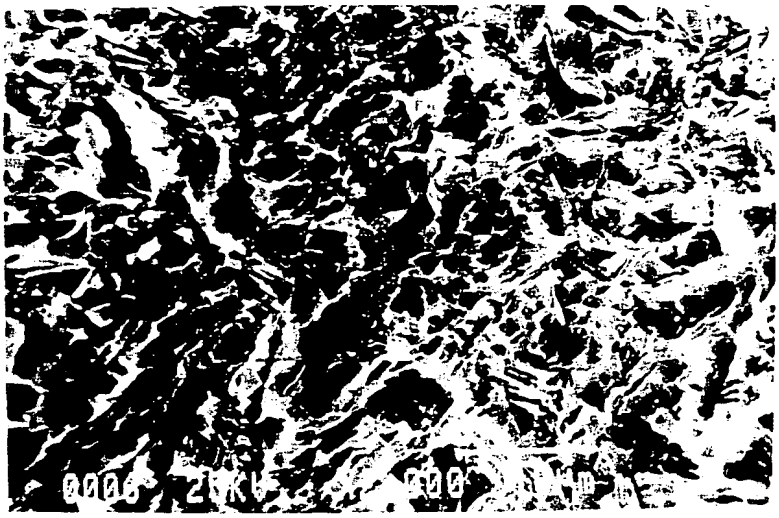


FIG. 9

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

47968-00035USCT

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/237,605	01/25/1999	RICHARD J. LAZZARA	IMPI.035-1	7280

30223 7590 07/23/2004

JENKENS & GILCHRIST, P.C.
225 WEST WASHINGTON
SUITE 2600
CHICAGO, IL 60606

JUL 30 2004

EXAMINER	
PREBILIC, PAUL B	
ART UNIT	**PAPER NUMBER**
3738	

DATE MAILED: 07/23/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

DOCKETED
DATE: 7/30/04
Reply Due DATE: 10/23/04
Resp Prompt 1/23/05
deadline

Office Action Summary	Application No.	Applicant(s)	
	09/237,605	LAZZARA ET AL.	
	Examiner	Art Unit	
	Paul B. Prebilic	3738	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12 April 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *11-16,51 and 57-75* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *11-16,51 and 57-75* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Claim Rejections - 35 USC 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> **The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.**

Claims 11-16, 51, and 60-75 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The terminology "uniform array of irregularities" or "substantially uniform array of irregularities" to described the degree to which the native oxide layer is removed or the uniformity of the roughness lacks original support and/or there is no guidance as to its affect on the metes and bounds of the claim language. Since there is no guidance in the original specification, it appears that even a bulk etched metal implant surface would be substantially uniform in roughness. Moreover, "substantially" is a broad term. *In re Nehrenberg*, 126 USPQ 383 (CCPA 1960) and see MPEP 2173.05(b) which is incorporated herein by reference. The specification fails to provide some standard for measuring that degree. Therefore, one of ordinary skill would not know what degree of roughness or native oxide layer would fall within the claim scope and what would not. The controlling case law appears to be that of *In re Mattison*, 184 USPQ 383 (CCPA 1960). It states:

> We are not persuaded by the board's reasoning that one skilled in the art would not be able to determine the scope of the claimed invention in terms

> of a specified percentage value. General guidelines are disclosed for a proper choice of the substituent Ep together with a representative number of examples. (emphasis added here)

The Board of Appeals was reversed because there were general guidelines as to what constituted a substantial increase. This is not the situation here where there are no guidelines in the specification, and the prior art does not give one a clear picture as to what constitutes a substantially uniform roughness and what does not. This is a critical and defining limitation of the claim and it must be clear as to what falls within its scope.

It is noted that the specification only uses the terminology "substantially uniform array of irregularities" to describe the resulting surface, and the Applicants' remarks suggest that removing substantially does not improve clarity; see page 8, first full paragraph of the response filed April 12, 2004. For this reasons, both "substantially uniform array of irregularities" and "uniform array of irregularities" is considered inadequately described.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> **The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.**

Claims 11-16, 51, and 60-75 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The scope of the claims is indefinite because of the ambiguity presented by the "substantially" terminology discussed in the 35 USC 112, first paragraph rejection.

Regarding claims 11-16, 51, and 60-67, the new language "without contacting said metal with non-titanium particles" appears to have two meanings, and thus, the scope is considered indefinite. In particular, it appears that his phrase means both contacting the surface with titanium particles and not contacting the surface with any particles whatsoever.

Claim Rejections Based Upon Prior Art

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 11-16 and 57-59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haruyuki et al (the translation of Japanese patent JP3146679A2) in view of Krueger (US 4,826,434). Haruyuki discloses an acid etched titanium implant surface with recesses having average depths of 0.5 to 5 microns; see the abstract and the "Technical Field" paragraph on page 2. Haruyuki discloses making dental repair and biorepair members including bone fixation devices and artificial dental roots, but

fails to disclose implants made with threads as claimed. However, Krueger teaches that it was known to make dental implants with threaded surfaces in order to sufficiently anchor the device into the bone. Hence, it is the Examiner position that it would have been obvious to put threads on the Haruyuki dental implants in order to allow them to be securely and quickly inserted into a bone hole without sliding out therefrom.

With regard to the new limitation pertaining to the minimum consumption of metal, the Examiner asserts that this process step would not affect the final surface property, and thus, the resultant product would be the same as one where there was a more than minimum consumption of metal; see MPEP 2113, which is incorporated herein by reference thereto.

With regard to claims 12 and 57-59, the Examiner posits that since a similar type of etching process is used to form irregularities on the surface of the same material as claimed that the surface irregularities of Haruyuki would inherently be the same as those set forth in the claims; i.e. cone-shaped and/or spaced about the prescribed distance.

Furthermore, upon review of Exhibit 1 and Exhibit B, Comparative Example 2 of the Dr. Gubbi declaration filed June 30, 2003, the Examiner concluded that the prior art treatments do result in cone-shaped elements; see the micrographs thereof and compare to the micrographs of Exhibit A. Thus, this evidence is used as evidence that cone-shaped elements are inherently present on the surface of Haruyuki.

Claims 51 and 60-75 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haruyuki et al (the translation of Japanese patent JP3146679A2) in view of Niznick

(US 5,571,017). Haruyuki meets the claim language as explained *supra* but fails to teach both a roughened region and an unroughened or other region, the tapered section, and the self-tapping section as required by the claims. However, Niznick teaches that it was known in the art to have different regions of roughness where the roughened portion begins below the top surface, a tapered section, and a self-tapping feature; see the abstract, Figure 1, column 2, lines 1-12, column 2, line 66 to column 3, line 24, column 4, lines 22-37, column 4, line 56 to column 5, line 6, and column 7, lines 9-24. Hence, it is the Examiner's position that it would have been obvious to have a smoother head portion in the Haruyuki invention for the same reasons that Niznick has the same.

Response to Arguments

Applicant's arguments filed April 12, 2004 have been considered but they are not persuasive.

In response to the argument that the Section 112, first paragraph rejection should be withdrawn, it is noted that the specification only uses the terminology "substantially uniform array of irregularities" to describe the resulting surface, and the Applicants' remarks suggest that removing substantially does not improve clarity; see page 8, first full paragraph of the response filed April 12, 2004. For this reasons, both "substantially uniform array of irregularities" and "uniform array of irregularities" is considered inadequately described. This is due to the fact that the case law cited in the rejection suggests a broad interpretation should be used, but the Applicants' arguments and specification suggest a narrow interpretation for this language. Therefore, the Examiner

suggest deleting the language both of these phrases entirely so that there is no confusion in this regard.

In response to the Applicants' argument that the "substantially" objection should be withdrawn, it is the Examiner's position that since there is a lack of guidance in this regard, it would not be proper to withdraw the rejection. This is due to the fact that the case law is relatively clear as to what is required and the present disclosure falls short of that standard.

The Applicants argue that Figure 1 of the present specification shows a substantially uniform texture while Figure 3 does not. However, the line between the two has not been made clear. It is not clear whether device with a smaller area than that shown in Figure 3 would constitute a substantially uniform texture.

In response to the arguments directed against the Haruyuki rejection that Haruyuki uses acid treatment to smoothen the surface not roughen it as alleged Krueger teaches, the Examiner asserts that Haruyuki does not teach smoothening the surface. Rather, Haruyuki explains that there is an optimum surface characteristic to obtain for cell adhesion and ongrowth. Acid treatment with a too strong acid (over 6% HF) leads to too large of pores sizes while a too weak acid (under 1% HF) leads to too small of pores sizes; see page 4, left column of the translation. Smoothness is not explicitly discussed. Rather, only rough edges and pores sizes are discussed. Furthermore, the fact that Harayuki wants to optimize pores size and depth to promote cell attachment does not teach away from Krueger, but instead teaches a way of achieving what both references desire: cell attachment and ongrowth.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Applicant should specifically point out the support for any amendments made to the disclosure, including the claims (MPEP 714.02 and 2163.06). Due to the procedure outlined in MPEP 2163.06 for interpreting claims, it is noted that other art may be applicable under 35 USC 102 of 35 USC 103(a) once the aforementioned issue(s) is/are addressed.

Applicant is respectfully requested to provide a list of all copending applications that set forth similar subject matter to the present claims. A copy of such copending claims is respectfully requested in response to this Office action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Paul Prebilic whose telephone number is ~~(703) 308-2905~~ 571 272-4751. The examiner can normally be reached on Monday-Thursday from 6:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Corrine McDermott, can be reached on (703) 308-2111. The fax phone number for this Technology Center is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application should be directed to the Technology Center 3700 receptionist whose telephone number is (703) 308-0858.

Paul Prebilic
Primary Examiner
Art Unit 3738

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/237,605	01/25/1999	RICHARD J. LAZZARA	IMPI.035-1	7280

30223 7590 12/09/2004

JENKENS & GILCHRIST, P.C.
225 WEST WASHINGTON
SUITE 2600
CHICAGO, IL 60606

EXAMINER	
PREBILIC, PAUL B	

ART UNIT	PAPER NUMBER
3738	

DATE MAILED: 12/09/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

DOCKETED
INIT. PB DATE: 12/15/04
ACTION: ~~Action~~ Advisory DATE: 12/23/04
Due - Deadline 1/23/05

Advisory Action	Application No.	Applicant(s)	
	09/237,605	LAZZARA ET AL.	
	Examiner	Art Unit	
	Paul B. Prebilic	3738	

--The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

THE REPLY FILED 26 November 2004 FAILS TO PLACE THIS APPLICATION IN CONDITION FOR ALLOWANCE. Therefore, further action by the applicant is required to avoid abandonment of this application. A proper reply to a final rejection under 37 CFR 1.113 may only be either: (1) a timely filed amendment which places the application in condition for allowance; (2) a timely filed Notice of Appeal (with appeal fee); or (3) a timely filed Request for Continued Examination (RCE) in compliance with 37 CFR 1.114.

PERIOD FOR REPLY [check either a) or b)]

a) ☒ The period for reply expires 4 months from the mailing date of the final rejection.

b) ☐ The period for reply expires on: (1) the mailing date of this Advisory Action, or (2) the date set forth in the final rejection, whichever is later. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of the final rejection. ONLY CHECK THIS BOX WHEN THE FIRST REPLY WAS FILED WITHIN TWO MONTHS OF THE FINAL REJECTION. See MPEP 706.07(f).

Extensions of time may be obtained under 37 CFR 1.136(a). The date on which the petition under 37 CFR 1.136(a) and the appropriate extension fee have been filed is the date for purposes of determining the period of extension and the corresponding amount of the fee. The appropriate extension fee under 37 CFR 1.17(a) is calculated from: (1) the expiration date of the shortened statutory period for reply originally set in the final Office action; or (2) as set forth in (b) above, if checked. Any reply received by the Office later than three months after the mailing date of the final rejection, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

1. ☐ A Notice of Appeal was filed on _____. Appellant's Brief must be filed within the period set forth in 37 CFR 1.192(a), or any extension thereof (37 CFR 1.191(d)), to avoid dismissal of the appeal.
2. ☐ The proposed amendment(s) will not be entered because:
   (a) ☐ they raise new issues that would require further consideration and/or search (see NOTE below);
   (b) ☐ they raise the issue of new matter (see Note below);
   (c) ☐ they are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal; and/or
   (d) ☐ they present additional claims without canceling a corresponding number of finally rejected claims.
   NOTE: _____.
3. ☒ Applicant's reply has overcome the following rejection(s): See Continuation Sheet.
4. ☐ Newly proposed or amended claim(s) _____ would be allowable if submitted in a separate, timely filed amendment canceling the non-allowable claim(s).
5. ☐ The a)☐ affidavit, b)☐ exhibit, or c)☐ request for reconsideration has been considered but does NOT place the application in condition for allowance because: _____.
6. ☐ The affidavit or exhibit will NOT be considered because it is not directed SOLELY to issues which were newly raised by the Examiner in the final rejection.
7. ☒ For purposes of Appeal, the proposed amendment(s) a)☐ will not be entered or b)☒ will be entered and an explanation of how the new or amended claims would be rejected is provided below or appended.

   The status of the claim(s) is (or will be) as follows:

   Claim(s) allowed: _____.

   Claim(s) objected to: _____.

   Claim(s) rejected: 11-16,51 and 57-75.

   Claim(s) withdrawn from consideration: _____.
8. ☐ The drawing correction filed on _____ is a)☐ approved or b)☐ disapproved by the Examiner.
9. ☐ Note the attached Information Disclosure Statement(s)(PTO-1449) Paper No(s). _____.
10. ☐ Other: _____

Paul B. Prebilic
Primary Examiner

Continuation of 3. Applicant's reply has overcome the following rejection(s): The 35 USC 112, first and second paragraph rejections have been overcome and/or withdrawn.

PATENT
IMPI:035

APPLICATION FOR UNITED STATES LETTERS PATENT

for

INFECTION-BLOCKING DENTAL IMPLANT

Inventors:

Richard J. Lazzara
Thomas S. Heylmun
Keith D. Beaty

EXPRESS MAIL MAILING LABEL
NUMBER EM580067740US
DATE OF DEPOSIT January 3, 1997
I hereby certify that this paper or fee is being deposited with the United States Postal Service "EXPRESS MAIL POST OFFICE TO ADDRESSEE" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to: Assistant Commissioner for Patents, Washington D.C. 20231.
Signature

INFECTION-BLOCKING DENTAL IMPLANT

CROSS REFERENCES TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Application No. 08/778,503, filed January 3, 1997, now issued as U. S. Patent No. 5,863,201, which is a non-provisional application claiming the benefit of U. S. Provisional Application No. 60/009,592, filed January 4, 1996 and which is also a continuation-in-part of U.S. Application No. 08/607,903, filed February 27, 1996, now issued as U.S. Patent No. 5,876,453, which claimed priority of PCT/95/15,576, filed November 30, 1995, and which is a continuation-in-part of U.S. Application No. 08/351,204, filed November 30, 1994, now abandoned.

FIELD OF THE INVENTION

This invention relates to dental implants intended for insertion in a hole provided in living jawbone for eventual support of artificial teeth. It is illustrated as realized in a cylindrical dental implant having a screw thread or screw threads on its outer surface, but it is not limited to that type of implant, and is applicable to all types of implants which share the general characteristic that while they are fitted into the living jawbone they extend out of it through the overlying gingival into the mouth wherein they support artificial teeth.

BACKGROUND OF THE INVENTION

The part of a dental implant that is in the living jawbone should have a roughened surface confronting the host bone for bonding with the bone, and the part of the same implant that is exposed in the mouth should have a smooth surface because a rough surface in that location might provide a site where bacteria can attach and proliferate. For hygienic reasons the exposed surfaces of the implant should be smooth, while for osseointegration purposes the surfaces of the implant confronting the host bone should be rough. Experience over many years has taught dentists practicing implantology that approximately eighteen months after an implant has been successfully placed in the jawbone of a patient and is performing its task of supporting artificial dentition, the bone surrounding the implant immediately beneath the overlying gingival tissue will in most cases be found to have receded a small distance, exposing to the soft

tissue a portion of the roughened surface of the implant which had been in bone. This phenomenon is illustrated in a book by Branemark, Zarb & Albrektsson entitled "Tissue-Integrated Prostheses" 1985, p56, Fig. 1-46. This event, occurring as it does beneath the gum tissue surrounding an artificial tooth, is not immediately visible. In spite of the most diligent hygienic practice, it presents the danger that bacteria which succeed in penetrating between the tooth and its surrounding tissue may attach themselves to the roughened surface, and there proliferate, and bring about an infection putting the implant and the tooth it supports in danger of failure.

In U.S. 4,988,299 an implant is disclosed which has a threaded portion and a smooth neck portion. No reference is made to roughening of the threaded portion or how smooth the neck portion should be. The neck portion is defined by having a diameter between the "core" diameter of the threaded portion and the outer diameter of the threads and it is disclosed to have a curved surface. The neck portion is said to have an axial length exceeding the settlement in bone level and it is intended to avoid exposure of the threads.

SUMMARY OF THE INVENTION

The present invention relates to an implant which is roughened to improve osseointegration with the bone but which does not provide a surface which can facilitate infection.

Observations based on practical experience of one of the present inventors over the past ten years or more have revealed that the recession described in the above-mentioned book tends to stop at the level where the implant places a load on the host bone. In a screw-type implant this level is approximately the beginning of the first turn of the screw thread near the gingival end of the implant. However, these observations also indicate that the stopping level is not precisely the same in all cases, and that in some cases the first thread may be exposed. At times, more than one thread is exposed, perhaps up to three threads.

According to the invention as illustrated in the accompanying drawings, the portion of the implant which has a roughened surface is limited to that portion which can be expected to remain in contact with the host bone after the expected bone recession has taken place. The head portion of the implant and the immediately-adjacent part of the heretofore roughened portion, including the initial part of the screw threads,

are made smooth. Preferably one to three threads will be left smooth, not roughened. Typically, a length of about 3mm below the top surface of the implant will be left smooth and not roughened with the remainder of the implant. Because the amount of bone that recedes will vary with different patients, one or more smooth threads may remain permanently in the bone along with the roughened threads. Although these smooth threads may not load the bone to the same degree as the roughened threads, nevertheless the smooth threads will still add significantly to the bone loading.

Since the exact amount of bone recession that will occur in a given patient cannot be determined in advance of the event with precision, the invention is useful to minimize the danger of infection from this source, that is, to block the infection. Good hygienic practice will continue to be required of the patient. With the invention, such good practice can be expected to be more fruitful than heretofore.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is described in greater detail with reference to the accompanying drawings, in which:

FIG. 1 is a side elevation of a dental implant according to the invention; *[[and]]*

FIG. 2 is an end view of the dental implant of FIG. 1.

FIGS. 3A and 3B *are scanning electron micrographs ("SEMs") of two titanium dental implants prepared in accordance with the present invention;*

FIGS. 4A and 4B *are SEMs of the same implants shown in FIGS. 3A and 3B, at a higher magnification level;*

FIG. 5 *is a graph of the results of an Auger electron spectroscopic analysis of a titanium surface that has been exposed to air;*

FIGS. 6A and 6B *are SEMs of two titanium dental implants prepared in accordance with the present invention; and*

FIGS. 7A and 7B *are SEMs of the same implants shown in FIGS. 7A and 7B, at a higher magnification level.*

DETAILED DESCRIPTION OF THE INVENTION

The implant 10 has a head portion 12, a neck portion 14 and a main body 16 which is roughened on its outer surface in the region 18. Such implants are normally

machined from titanium or a titanium alloy and are smooth, until a portion is roughened to facilitate osseointegration with bone. The head portion 12, the neck portion 14, and a small region 20 of the main body 16 immediately adjacent the neck portion, encompassing the first to third thread turns, are smooth. To achieve this result the portions of the implant intended to remain smooth during and after the roughening procedure may be covered during that procedure. For example, if the roughening procedure includes an acid-etching step or steps, these parts may be covered with a suitable wax prior to immersing the implant in the etching acid. A preferred method of roughening the surface is disclosed in copending U. S. patent ~~application Serial No. 08/607,903~~ *5,876,453* mentioned above and incorporated by reference herein. The process has two steps, the first being removal of native oxide from titanium by contact with an aqueous hydrofluoric acid solution, followed by etching with a mixture of sulfuric and hydrochloric acids.

When the implant 10 is first installed in a bore prepared for it in a patient's jawbone, the implant is buried in bone up to and including the head portion 12, to the level indicated by line A - A in figure 1. The healing phase then begins, during which new bone is formed close to the immobile, resting implant, and the implant will remain buried in the bone, up to the head portion. All the implant, including the neck portion 12, will confront the host bone in the early part of the healing phase. Thereafter when the implant is loaded and the remodeling phase begins (overlapping the healing phase) during exposure to masticatory forces, the newly formed bone remodels under the applied load until, after about eighteen months, a steady state is achieved. In this state the anchoring bone will be found to have undergone a reduction in height (bone recession) immediately adjacent the implant. The amount of this recession can vary from case to case, between the level indicated by the solid curved lines 30 and the level indicated by the broken curved lines 32, for example, exposing the head portion 12, the neck portion 14 and some or all of the immediately adjacent region 20 of the threaded main body 16. In some cases region 20 may extend further, up to about the third thread. Another way to define regions 14 and 20 is that roughening of the implant begins about 3mm below the upper flat surface 15 of the implant 10, which receives connecting parts of the dental restoration.

According to the invention, that region 20 immediately adjacent to the neck portion 14 of the implant is maintained smooth so that when the remodeling phase is completed, there will be little or no roughened implant surface exposed to the soft tissue under the dental restoration that is supported on the implant. The exact dimensions of the smooth region 20 cannot be precisely established for all cases. A length corresponding to about one turn of the screw thread is suitable for many cases, but up to three threads may be left smooth.

The native oxide layer that forms naturally on titanium when it is exposed to air is actually a combination of different oxides of titanium, including TiO, TiO_2, Ti_2O_3 and Ti_3O_4. The concentration of these oxides in the titanium body diminishes with distance from the surface of the body, The oxide concentration may be measured in an Auger spectrometer.

Auger electron spectroscopy (AES) measures the energy of Auger electrons produced when an excited atom relaxes by a radiationless process after ionization by a high energy electron, ion or x-ray beam. The spectra of a quantity of electrons emitted as a function of their energy reveal information about the chemical environment of the tested material. One of the major uses of AES is the depth profiling of materials, to reveal the thickness (depth) of the oxide layer on the surfaces of materials. These Auger electrons lie in an energy level that extends generally between the low energy level of the emission of secondary electrons up to the energy level of the impinging electron beam. In this region, small peaks will occur in the spectra at certain energy levels that identify the existence of certain elements in the surface.

As used herein, the term "native oxide layer" refers to the layer which extends from the surface of the material to the depth at which the energy of the peak-to-peak oxygen profile as measured in an Auger electron spectrometer decreases by one-half. For example, in the peak-to-peak oxygen profile reproduced in FIG. 5, the thickness of the native oxide layer was 130 Angstroms, which is the depth at which the oxygen profile dropped to half its maximum intensity. Thus, removal of a 130-Angstrom layer from the surface of the titanium body would remove the native oxide layer

The manner in which the surface of the implant is roughened and the resulting surface topography will now be described. According to one aspect of the present

invention, the native oxide layer is removed from the surface of a titanium implant prior to the final treatment of the surface to achieve the desired topography. After the native oxide layer is removed, a further and different treatment of the surface is carried out in the absence of unreacted oxygen to prevent the oxide layer from re-forming until after the desired surface topography has been achieved. It has been found that this process permits the production of unique surface conditions that are substantially uniform over the implant surface that is so treated.

Removal of the native oxide layer can be effected by immersing the titanium implant in an aqueous solution of hydrofluoric (HF) acid at room temperature to etch the native oxide at a rate of at least about 100 Angstroms per minute. A preferred concentration for the hydrofluoric acid used in this oxide removal step is 15% HF/H_2O. This concentration produces an etch rate of approximately 200-350 Angstroms per minute at room temperature, without agitation, so that a typical native oxide layer having a thickness in the range from about 70 to about 150 Angstroms can be removed in about one-half minute. Other suitable etching solutions for removing the native oxide layer, and their respective etch rates, are:

50% HF--etch rate about 600 to 750 Angstroms/min.
30% HF--etch rate about 400 to 550 Angstroms/min.
10% HF--etch rate about 100 to 250 Angstroms/min.

A 100% HF was found to be difficult to control, and the etch rate was not determined. The preferred 15% HF solution allows substantially complete removal of the native oxide layer with minimum further consumption of the titanium surface after the implant is removed from the solution.

The native oxide layer may be removed by the use of other acids, or by the use of techniques other than acid etching. For example, the Swart et al. article cited above mentions the use of plasma cleaning to remove thin oxides. Regardless of what technique is used, however, it is important to remove substantially all the native oxide from the implant surface that is intended to interface with the living bone, so that the subsequent treatment of that surface produces a substantially uniform surface texture to promote uniform bonding to the living bone. The native oxide layer is preferably

removed from substantially the entire bone-interfacing surface of the implant. In the case of screw-type dental implants, the bone-interfacing surface typically includes the entire implant surface beyond a narrow collar region on the side wall of the implant at the gingival end thereof. This narrow collar region preferably includes the first turn of the threaded portion of the implant. It is preferred not to etch the gingival end itself, as well as the narrow collar region, because these portions of the implant are normally fabricated with precise dimensions to match abutting components which are eventually attached to the gingival end of the implant. Moreover, it is preferred to have a smooth surface on that portion of a dental implant that is not embedded in the bone, to minimize the risk of infection.

The treatment that follows removal of the native oxide layer must be different from the treatment that is used to remove the native oxide layer. A relatively aggressive treatment is normally required to remove the oxide layer, and such an aggressive treatment does not produce the desired uniform surface texture in the resulting oxide-free surface. Thus, after the native oxide layer has been removed, the resulting implant surface is immediately rinsed and neutralized to prevent any further attack on the implant surface. The surface is then subjected to the further, and different, treatment to produce a desired uniform surface texture. For example, the preferred further treatment described below is a relatively mild acid-etching treatment which forms a multitude of fine cone-like structures having relatively uniform, small dimensions. Because of the prior removal of the native oxide layer, even a mild second treatment of the implant surface can produce a substantially uniform effect over substantially the entire bone-interfacing surface of the implant.

Prior to removing the native oxide layer, the oxide-bearing surface may be grit blasted, preferably with grit made of titanium or a dilute titanium alloy. As is taught in the U.S. Patent No. 5,607,480, the use of a grit made of titanium avoids contaminating the surface of a titanium implant. Thus, for a dental implant made of commercially pure ("CP") titanium, the blasting material may be CP B299 SL grade titanium grit. The preferred particle size for this grit is in the range from about 10 to about 60 microns (sifted), and the preferred pressure is in the range from about 50 to about 80 psi.

The surface treatment that follows removal of the native oxide layer from the implant surface may take several forms, singly or in combination. The preferred treatment is a second acid etching step, using an etch solution ("Modified Muriaticetch") consisting of a mixture of two parts by volume sulfuric acid (96% by weight H_2SO_4, 4% by weight water) and one part by volume hydrochloric acid (37% by weight HCl, 63% by weight water) at a temperature substantially above room temperature and substantially below the boiling point of the solution, preferably in the range from about 60°C to about 80°C. This mixture provides a sulfuric acid/hydrochloric acid ratio of about 6:1. This preferred etch solution is controllable, allowing the use of bulk etch times in the range from about 3 to about 10 minutes. This solution also can be prepared without the risk of violent reactions that may result from mixing more concentrated HCl solutions (e.g., 98%) with sulfuric acid. This second etching treatment is preferably carried out in the absence of unreacted oxygen, and before the implant surface has been allowed to re-oxidize, following removal of the native oxide layer. Of course, the implants may be kept in an inert atmosphere or other inert environment between the two etching steps.

The second etching step produces a surface topography that includes many fine projections having a cone-like aspect in the sub-micron size range. Because of the fine roughness of the surface, and the high degree of uniformity of that roughness over the treated surface, the surface topography produced by this process is well suited for osseointegration with adjacent bone. As illustrated by the working examples described below, the final etched surface consists of a substantially uniform array of irregularities having peak-to-valley heights of less than about 10 microns. Substantial numbers of the irregularities are substantially cone-shaped elements having base-to-peak heights in the range from about 0.3 microns to about 1.5 microns. The bases of these cone-shaped elements are substantially round with diameters in the range from about 0.3 microns to about 1.2 microns, and spaced from each other by about 0.3 microns to about 0.75 microns. The SEMs discussed below, and reproduced in the drawings, illustrate the surface topography in more detail.

The acid-etched surface described above also provides a good site for the application of various materials that can promote bonding of the surface to adjacent bone. Examples of such materials are bone-growth-enhancing materials such as bone

minerals, bone morphogenic proteins, hydroxyapatite, whitlockite, and medicaments. These materials are preferably applied to the etched surface in the form of fine particles which become entrapped on and between the small cone-like structures. The bone-growth-enhancing materials are preferably applied in the absence of oxygen, e.g., using an inert atmosphere.

The roughness of the surface to which these materials are applied enhances the adherence of the applied material to the titanium implant. The uniformity of the rough surface enhances the uniformity of the distribution of the applied material, particularly when the material is applied as small discrete particles or as a very thin film.

A preferred natural bone mineral material for application to the etched surface is the mineral that is commercially available under the registered trademark "BIO-OSS". This material is a natural bone mineral obtained from bovine bone; it is described as chemically comparable to mineralized human bone with a fine, crystalline biological structure, and able to support osseointegration of titanium fixtures.

The invention will be further understood by reference to the following examples, which are intended to be illustrative and not limiting:

EXAMPLE NO. 1

A batch of 30 screw-type cylindrical implants made of CP titanium were grit blasted using particles of CP B299 SL grade titanium grit having particle sizes ranging from 10 to 45 microns, at a pressure of 60 to 80 psi. After grit-blasting, native oxide layer was removed from the implant surfaces by placing 4 implants in 100 ml. of a 15% solution of HF in water at room temperature for 30 seconds. The implants were then removed from the acid, neutralized in a solution of baking soda, and placed in 150 ml. of "Modified Muriaticetch" (described above) at room temperature for 3 minutes. The implants were then removed from the acid, neutralized, rinsed and cleaned. All samples displayed very similar surface topographies and a high level of etch uniformity over the surface, when compared with each other in SEM evaluations. Consistency in the surface features (peaks and valleys) was also observed. The SEMs in FIGS. 3A, 3B, 4A and 4B show the surfaces

of two of the implants, Sample A-1 and Sample A-4, at magnifications of 2,000 and 20,000. It will be observed that the surface features over the areas shown are consistent and uniform. The scale shown on the X20,000 photographs is 1 micron=0.564 inch. At this magnification the surfaces appear to be characterized by a two-dimensional array of cones ranging in height (as seen in the SEMs) from about 0.17 inch to about 0.27 inch; the base diameters of these cones varied from about 0.17 inch to about 0.33 inch. Converting these numbers to metric units on the above-mentioned scale (1 micron=0.564 inch) yields:

cone height range (approx.)=0.30 to 0.50 micron
cone base diameter range (approx.)=0.30 to 0.60 micron.

The same degree of uniformity was found in all the samples, and from sample to sample, at magnifications of 2,000 and 20,000, as compared with similar samples subjected to bulk etching without prior removal of the native oxide, as described in EXAMPLE NO. 2 below.

EXAMPLE NO. 2

Four of the implants that had been grit blasted as described in EXAMPLE NO. 1 above were placed in 150 ml. of "Modified Muriaticetch" for 10 minutes. The implants were then removed, neutralized, rinsed and cleaned. SEM photographs taken at magnifications of 2,000 and 20,000 showed that the bulk etch solution failed to remove the native oxide layer after 10 minutes in the etch solution. The failure to remove the native oxide layer (100-150 Angstrom units thick) resulted in a non-uniformly etched surface, as depicted for example in FIG. 3 of U.S. Patent No. 5,876,453. In areas of the implant surfaces where the native oxide was removed, the topography was similar to that observed on the implants in EXAMPLE NO. 1.

EXAMPLE NO. 3

The procedure of this example is currently preferred for producing commercial implants. A batch of screw-type implants made of CP titanium were immersed in a 15% solution of HF in water at room temperature for 60 seconds to

remove the native oxide layer from the implant surfaces. A plastic cap was placed over the top of each implant to protect it from the acid. The implants were then removed from the acid and rinsed in a baking soda solution for 30 seconds with gentle agitation. The implants were then placed in a second solution of baking soda for 30 seconds, again with agitation of the solution; and then the implants were rinsed in deionized water. Next the implants were immersed in another solution of two parts by volume sulfuric acid (96% by weight $H_2 SO_4$, 4% by weight water) and one part by volume hydrochloric acid (37% by weight HCl, 63% by weight water) at 70°C for 5 minutes. The implants were then removed from the acid and rinsed and neutralized by repeating the same steps carried out upon removal of the implants from the HF. All samples displayed very similar surface topographies and a high level of etch uniformity over the surface, when compared with each other in SEM evaluations. Consistency in the surface features (peaks and valleys) was also observed. The SEMs in FIGS. 6A, 6B, 7A and 7B show the surfaces of two of the implants, Sample 705MB and Sample 705MC, at magnifications of 2,000 and 20,000. It will be observed that the surface features over the areas shown are consistent and uniform. The scale shown on the X20,000 photographs is 1 micron=0.564 inch. At this magnification the surfaces appear to be characterized by a two-dimensional array of cones ranging in height (as seen in the SEMs) from about 0.17 inch to about 1.128 inch; the base diameters of these cones varied from about 0.17 inch to about 1.128 inch. Converting these numbers to metric units on the above-mentioned scale (1 micron=0.564 inch) yields:

cone height range (approx.)=0.30 to 2.0 microns

cone base diameter range (approx.)=0.30 to 2.0 microns.

The same degree of uniformity was found in all the samples, and from sample to sample, at magnifications of 2,000 and 20,000, as compared with similar samples subjected to bulk etching without prior removal of the native oxide, as described in EXAMPLE NO. 2 above.—

CLAIMS

1. A dental implant having a head portion, a neck portion, and a threaded portion for contact with bone wherein said head and neck portions are provided with a smooth surface for blocking infection and said threaded portion is roughened to promote osseointegration with bone while leaving at least one thread adjacent said neck portion smooth and unroughened.

2. A dental implant of claim 1 wherein up to three threads adjacent said neck portion are left smooth.

3 A dental implant of claim 1 wherein a length of about 3 mm of said implant including said head, neck, and adjacent threaded portions is left smooth.

4. A dental implant of claim 1 wherein the head, neck, and threaded portions left smooth have a surface created by machining.

5. A dental implant of claim 1 wherein said implant is titanium or a titanium alloy and said roughness is created by a two-stop process in which the native oxide is removed by contact with an aqueous hydrofluoric acid solution and followed by etching of the resulting surface with a mixture of sulfuric and hydrochloric acids.

6. A dental implant comprising

(a) a roughened bottom portion for facilitating osseointegration with bone;

(b) a smooth neck portion adjacent said roughened portion for contact with gingival tissue; and

(c) a smooth head portion adjacent said neck portion for receiving a dental restoration; wherein said roughened portion of (a) is threaded and at least one thread adjacent said neck portion is left smooth and unroughened.

7. A dental implant of claim 6 wherein up to three threads adjacent said neck portion are left smooth and unroughened.

8. A dental implant of claim 6 wherein the length of said head, neck, and smooth threads is a total of about 3 mm.

9. A dental implant of claim 6 wherein the head, neck, and threaded portions left smooth have a surface created by machining.

10. A dental implant of claim 6 wherein said implant is titanium or titanium alloy and said roughness is created by a two-step process in which the native oxide is removed by contact with aqueous hydrofluoric acid solution and followed by etching of the resulting surface with a mixture of sulfuric and hydrochloric acids.

ABSTRACT

An infection-blocking dental implant in which a threaded portion which contacts bone is roughened except for up to three threads which may be exposed by bone recession after implantation, which have a smooth surface . Preferably, the implant is of titanium or titanium alloy and the threaded portion is roughened by a two-step acid treatment.

Customer No. 30223 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application Of:	)	Atty. Docket No.: 47168-00035USC1
	)	
Richard J. Lazzara	)	Examiner: Paul Prebilic
Thomas S. Heylmun	)	
Keith D. Beaty	)	Group Art Unit: 3738
	)	
Application No.: 09/237,605	)	
	)	
Filed: January 25, 1999	)	
	)	
For: Infection-Blocking Dental Implant	)	

DECLARATION OF PRABHU GUBBI

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

I, Prabhu Gubbi, declare that:

A. I reside at 4445 SW Oakhaven Lane, Palm City, FL 34990.

B. I have degrees in Mechanical Engineering and Foundry Engineering from Bangalore University, India. I also have a Ph.D. degree in Materials Engineering from Auburn University. Since receiving my Ph.D., I have been employed as an engineer with several corporations where I have worked as a materials scientist. Currently, I am a materials scientist with Implant Innovations, Inc ("*3i*").

C. In the course of my work at *3i*, I have examined numerous surfaces of objects used in dental implantology. One of the machines that I use to examine these surfaces is a Scanning Electron Microscope (SEM). The machine that I use is made by Aspex Instruments

LLC, Model No. PSEM II. Another machine used to measure surface roughness and surface area is a MicroXAM Surface Mapping Microscope (SMM) made by ADE Phase Shift, Model No. Micro XAM 100.

D. At the request of *3i*'s attorneys, I have carried out certain inspections of commercially pure titanium implants after they have been exposed to various treatments and compared the results with those of the methodology in the subject patent application, which is owned by *3i*. The results of this work are discussed below. In one series of tests (Exhibit A), a titanium dental implant was given a treatment according to the method described in this patent application to produce an Osseotite® surface, which is commercially available on *3i*'s dental implants. In the second series of tests (Exhibit B), titanium implants were exposed to the two-step procedure described in a Japanese published patent application, JP 3146679 A2 to Haruyuki. A third series of tests (Exhibit C) exposed titanium implants to a group of mineral acids. A fourth series of tests (Exhibit D) exposed titanium implants to a grit blasting step, followed by exposure to a group of mineral acids. I understand that my report is to be submitted to the U.S. Patent and Trademark Office in connection with the subject patent application.

First Test - Osseotite® Surface (Exhibit A)

E. A commercially pure titanium dental implant, after machining to form the implant's threaded shape, was first immersed in 8.45 wt% hydrofluoric acid for 60 seconds to remove the native oxide layer. After rinsing in deionized water with baking soda, followed by a rinse in deionized water, the implant was immersed in a mixture of one part by volume of 37 wt% hydrochloric acid and 7.5 parts by volume of 84.5 wt% sulfuric acid for 7 minutes at 60-70°C. The resulting surface is shown in Exhibit A, which includes an SEM photograph having a magnification of 2,000 times taken with the SEM machine and a three-dimensional

representation of the Osseotite® surface produced by the SMM machine adjacent to the SEM photograph. For comparison, the second sheet in Exhibit A includes an SEM photograph of the intermediate surface after using hydrofluoric acid to remove the native oxide (Stage I), and an SEM photograph after that intermediate surface has been further etched by the mixture of hydrochloric and sulfuric acids to achieve the Osseotite® surface (Stage II). As seen in these SEM photographs, the mixture of hydrochloric and sulfuric acids further roughens the intermediate surface after its native oxide was removed with hydrofluoric acid.

Second Test - Japanese Patent Application (Exhibit B)

F. A series of 4 mm diameter dental implants made of commercially pure titanium were taken from regular production after machining to form the implant, but before the implants had been provided with any type of treatment. Except for Comparative Example 1, each implant was dipped in hydrofluoric acid solutions using the conditions in the examples of the translation of the Japanese patent application, JP 3146679 A2, and recorded in Table "B" in the front of Exhibit B. Post-Treatment with mixtures of hydrofluoric acid and hydrogen peroxide was carried out where the examples used such post-treatments.

G. I photographed each implant after it was exposed to the treatments in the examples of the Japanese Patent Application using the SEM machine. SEM photographs having a magnification of 2000 times were taken of each implant and are shown in Exhibit B, identified by the example designations stated in the translation of JP 3146679 A2 at pages 5-6. In addition to the SEM photographs, the SMM machine was also used to examine each implant after the treatments, and the SMM representation of each surface is shown adjacent to the SEM photograph. A region of the surface measuring 162.8 μm by 123.3 μm was examined with the SMM machine. The area of this region would be 20.073 μm^2 if it were a flat plane. The

Comparative Example 1 was used as the base line for the area of the machined surface before pre-treatment and post-treatment. The Comparative Example 2 provides insight on the effect of only the pre-treatment step on the machined surface, since no post-treatment was performed in Comparative Example 2.

H. I conclude from the information provided in Table "B" that the maximum increase in the surface area was only 7.5%, which was found in the Experimental Example 2. From these SEM photographs and the three-dimensional representations of the surfaces, it appears that exposure of titanium implants to hydrofluoric acid treatments produced less roughening than reported by the Japanese Patent Application. In fact, the machining marks are still visible on many of the surfaces. Further, the post-treatment with hydrofluoric acid and hydrogen peroxide appears to smoothen the surface, which is consistent with the teaching at column 2 on page 4 of the translation of the Japanese Patent Application. Finally, the treatments of the Japanese patent application produced surfaces that do not resemble the surface achieved by the methodology of the subject patent application, as shown in Exhibit A.

Third Test - Mineral Acid Exposure (Exhibit C)

I. A series of 4 mm diameter dental implants made of commercially pure titanium were taken from regular production after machining to form the implant, but before the implants had been provided with any type of treatment. Each implant was dipped in a mineral acid solution having the concentration and temperature shown in Table "C," located at the front of Exhibit C.

J. I photographed each implant before and after it was exposed to the acid solution using the SEM machine. SEM photographs having a magnification of 2000 times are attached to Exhibit C. The SMM machine was also used to examine each implant before and after acid

treatment. A region of the surface measuring 162.8 μm by 123.3 μm was examined. The area of this region would be 20.073 μm^2 if it were a flat plane. The acid treatments had only a small effect on the surface area. In some cases, the area increased slightly and, in other cases, the area was reduced slightly. A reduction in surface area may be attributed to smoothing of the machining marks on the surface of the implants. The maximum increase in surface area was found to be 18.8%, produced by exposure to 49% HF for 5 minutes at 24°C (Test Sample 4). In that example, the machining marks are no longer visible and the titanium metal grains can be seen on the surface.

K. I conclude from the information provided in Exhibit C that exposure of machined titanium implants to the mineral acids produced little effect, except for hydrofluoric acid, which produced a surface in which the grain structure could be seen. None of the acids were capable of providing a surface roughness of twice the initial value (*i.e.*, 100%). Furthermore, the mineral acids produced surfaces that do not resemble the surface achieved by the methodology of the subject patent application, as shown in Exhibit A.

Fourth Test - Grit Blast Plus Mineral Acid Exposure (Exhibit D)

L. A second series of 4 mm dental implants made of commercially pure titanium was taken from regular production after machining to form the implant, but before the implants were provided with any further treatment. Each implant was subjected to grit blasting by Biocoat, Inc., using aluminum oxide #60 grit at a pressure of 20-60 psig. Thereafter, each grit blasted implant was dipped in an acid solution having the same concentration and at the same temperature as used in the Third Tests (Exhibit C) mentioned above. After remaining in the acid solution for the length of time stated in Table "D," which is at the front of Exhibit D, each implant was rinsed in reverse osmosis/deionized water, isopropyl alcohol and dried with a hot air gun.

M. I took photographs of each grit-blasted implant before and after it was exposed to the acid solution using the SEM machine. SEM photographs having a magnification of 2000 times are attached to Exhibit D. The SMM machine was also used to examine each implant before and after acid treatment. A region of the surface measuring 162.8 μm by 123.3 μm was examined. The area of this region would be 20.073 μm^2 if it were a flat plane. It is evident that the grit blasting increased the area significantly, compared to the surface of machined implants. The grit-blasted surface area was increased by acid treatment in some cases and decreased in others, with the maximum increase being 10.7% after exposure to nitric acid (Test Sample 1) and the maximum decrease on surface area being 34.4% after exposure to hydrofluoric acid (Test Sample 4). In no case did the acid exposure increase the surface area by a factor of two (*i.e.*, 100%).

N. I conclude that the exposure of the grit-blasted implant surfaces to these mineral acids did not produce a surface resembling the surface shown in the photographs of the subject patent application, as shown in Exhibit A.

O. The undersigned, being hereby warned that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this Declaration, declares that the facts set forth in this Declaration are true, and all statements made of this own knowledge are true, and all statements made on information and belief are believed to be true.

Date: 05-23-2003

Prabhu Gubbi

Customer No. 30223 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application Of:	Atty. Docket No.: 47168-00035USC1
Richard J. Lazzara Thomas S. Heylmun Keith D. Beaty	Examiner: Paul Prebilic
	Group Art Unit: 3738
Application No.: 09/237,605	
Filed: January 25, 1999	
For: Infection-Blocking Dental Implant	

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

In response to the Office Action dated October 22, 2001, in the subject application, the declarant wishes to provide the following information supporting patentability of the invention claimed in the application.

1. I am Dr. Stephan S. Porter holding the degrees of M.S.D. from Indiana University School of Dentistry and of DDS and MS from the Ohio State University College of Dentistry. I have been employed by Implant Innovations, Inc. ("*3i*"), since July 1997, and currently hold the title of Senior Director of New Product Development and Research.

2. I am familiar with the pending claims, claims 11-50, that are directed to an implant having a certain type of surface. I am aware of the Office Action dated October 22, 2001, and the obviousness rejections in that Office Action. I understand that the analysis of the patentability of claims 11-50 should take into account certain facts related to the clinical success and the

commercial success of the claimed implant. I wish to provide evidence showing that dental implants having a roughened surface as claimed in the application have achieved substantial clinical efficacy. Furthermore, I wish to provide evidence showing that the implants having the claimed surface have been commercially successful, as evidenced not only by *3i*'s own sales figures, but also by competitors' marketing literature that suggests that even *3i*'s competitors have recognized the commercial success of the claimed implants.

3. Dental implants having a roughened surface according to the invention have been designated to have an Osseotite® surface by *3i*, the assignee of the present application. Attached as Exhibit "A" is a surface map of the Osseotite® surface made by an interferometric microscope. The threaded implant is made of titanium and has been prepared in accordance with a two-step, acid-etch treatment wherein the native oxide layer is substantially removed via hydrofluoric acid and the resultant surface is etched with a combination of sulfuric and hydrochloric acids. The resulting topography has a substantially uniform array of substantially cone-shaped irregularities with peak-to-valley heights of less than 10 microns. I have personally placed and restored numerous implants, including *3i*'s Osseotite® implants.

4. Implants with an Osseotite® surface, like that shown in Exhibit "A," have been marketed by *3i* since 1996. Sales of implants with the Osseotite® surface have rapidly increased relative to *3i*'s implants with other types of surfaces since 1996. In 2001, implants with the Osseotite® surface accounted for 94% of all implants sold by *3i*, as shown in the table below.

U.S. Sales Year	% Implants Sold Having Osseotite® Surface	% Implants Sold Without Osseotite® Surface
1996	17	83
1997[1]	30-40	60-70
1998	58	42
1999	87	13
2000	90	10
2001	94	6

5. Implants having different types of surfaces other than an Osseotite® surface were offered for sale at the same time, as shown by ***3i***'s 1997 Surgical Catalog, 1998, 2000, 2001, and 2002 Price Lists, and 2000 Surgical Catalog, all of which are attached as Exhibit "B." Threaded implants with machined titanium surfaces and cylindrical implants having plasma sprayed titanium surfaces (TPS) were also available. Generally, where ***3i*** offers for sale an implant with the Osseotite® surface, a threaded implant of the same size with a machined surface is offered, and also a cylindrical implant with a TPS surface may be offered. See, e.g., Exhibit "B," 2000 Surgical Catalog, pp. 4, 5, 8, 9, 12, 13, 16, 17, 22, 23, 28 and 29. When comparing the machined surface implants and the TPS implants with the Osseotite® surface, the difference between the implants is related to the surface in contact with bone. It can be concluded that dental clinicians prefer to use the Osseotite® surface rather than the machined surface or the TPS surface. In each size, implants having an Osseotite® surface are more expensive than the threaded implants with the machined surface and the cylindrical implants having the TPS surface, as shown in the Price Lists (Exhibit B). Thus, the commercial success of the Osseotite® surface cannot be attributed to a cost advantage.

[1]Estimates based on actual number sold between July and December 1997.

6. The success of implants having an Osseotite® surface is related to the superior osseointegration that it achieves. After being installed, implants must be allowed to integrate with the adjacent bone in order that forces which will be imposed by an artificial tooth installed on the implant can be transferred to the bone. Failure to achieve osseointegration means that the implant loosens and must be removed. Traditionally, the period required for osseointegration had been three to six months after installation of the implant, depending on the location where the implant is installed. In 1999, after clinical experience and experimental evidence showed that the time required for functional osseointegration was significantly reduced for implants having Osseotite® surfaces, ***3i*** began recommending that its Osseotite® implants could be loaded with the final prosthesis after only two months of osseointegration, regardless of the location at which the implant is placed. The United States Food and Drug Administration approved of ***3i***'s marketing of the Osseotite® implants in this manner and a copy of ***3i***'s FDA submittal is enclosed as Exhibit C. As will be seen in the clinical tests reported in Exhibit C, the Osseotite® surface was found to have a particularly suitable roughness for migration of osteogenic cells needed for osseointegration of bone with the titanium surface of the implant.

7. As can be seen in the table in paragraph 4 above, sales of ***3i***'s implants having Osseotite® surfaces increased from 58% in 1998 to 84% in 1999 relative to all implants sold. I attribute this commercial success of the Osseotite® surface to the fact that the clinically-proven enhanced osseointegration achieved by the Osseotite® surface satisfied a long-felt need in that clinicians (as well as patients) would much prefer to reduce the time during which the patient lacks the final prosthesis. Thus, the Osseotite® surface has made possible an important advancement in the art of implantology, as has been recognized by patients, dentists, and ***3i***'s own competitors.

8. From the mid-1980's until 1996, when *3i* introduced its Osseotite® surface, the vast majority of implants that were sold to clinicians in the United States had either a machined surface, a TPS surface, or an HA (hydroxy apatite) surface. In recent years, the commercial success of *3i*'s Osseotite® surface has been recognized by competitors. Exhibit "D" includes marketing literature in which a competitor is marketing an implant that has a roughened surface (not TPS or HA, both of which are roughened surfaces) that is compared with the Osseotite® surface of *3i*. This competitive literature is dated between 1998 and 2001, after the clinical success of *3i*'s Osseotite® surface had become well-documented. In the first piece of literature, dated 2000, Steri-Oss, a Nobel Biocare subsidiary, is comparing its acid-etched surface to *3i*'s Osseotite® surface. In the second piece of literature, Nobel Biocare's commercial journal entitled "Applied Osseointegration Research Journal" dated October 2000, Nobel Biocare compares its TiUnite™ surface with *3i*'s Osseotite® surface at pp. 25-30. In the third piece of literature, dated 1998, ITI Straumann compares its SLA surface (which was apparently to be commercially released in the United States in late 1998) with *3i*'s Osseotite® surface. In the fourth piece of literature, dated 2001, LifeCore Biomedical compares its RBM™ surface with *3i*'s Osseotite® surface and Straumann's SLA surface. As these companies represent the world's largest dental implant manufacturers that sell implants in the United States, it is evident that competitors consider the Osseotite® surface to be the "Gold Standard" to which they compare their own roughened surfaces. Competitive flattery via these product comparisons is compelling evidence of the commercial success of *3i*'s Osseotite® surface.

9. The undersigned, being hereby warned that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this

Declaration, declares that the facts set forth in this Declaration are true, and all statements made of his own knowledge are true, and all statements made on information and belief are believed to be true.

Date: 4/18/02

Stephan S. Porter

As there are no related proceedings, no information is provided in the Related Proceedings Appendix.